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TOPOGRAPHIC AND GEOLOGIC SURVEY OF PENNSYLVANIA.

REPORT No. 3.

GEOLOGY OF THE OIL AND GAS FIELDS OF THE CLARION QUADRANGLE

By M. J. MUNN.

SURVEYED IN CO-OPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY

HARRISBURG:
C. E. AUGHINBAUGH, PRINTER TO THE STATE OF PENNSYLVANIA
1910

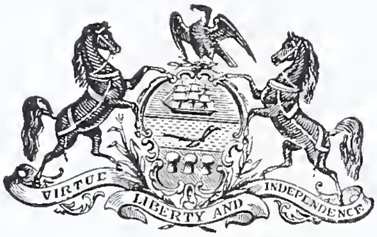
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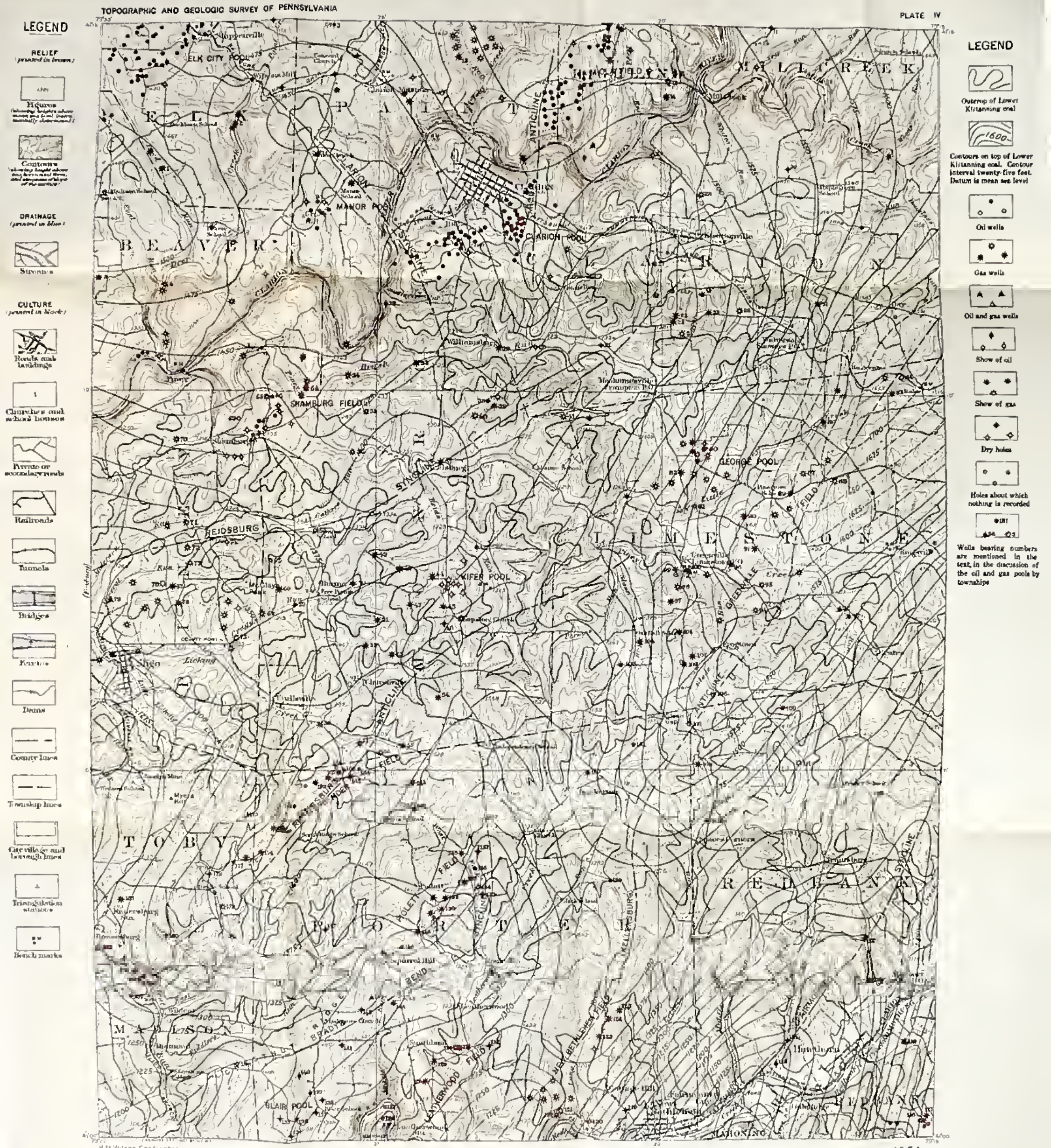
PLATE IV



H M Wilson, Geographer
Robt D Cummin and J H Jennings in charge of section
Topography by Robt D Cummin and E W McCrary
Control by E L McNair and W T Griswold
Surveyed in 1906 and 1908
Surveyed in cooperation with the State of Pennsylvania

MAP OF CLARION QUADRANGLE SHOWING OIL POOLS, GAS POOLS, ELEVATIONS OF WELLS, AND STRUCTURE CONTOURS ON BASE OF LOWER KITTANNINO COAL

Geology by M. J. Munn and E. F. Lines,
under the direction of Geo. H. Ashley

Scale $\frac{1}{62500}$

Contour interval 20 feet
Datum is mean sea level

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Pa.

162505

CONTENTS.

Page.

List of Illustrations, 9
Letter of Transmittal, 11
Introduction, 13

Description of the surface:

  Location, 15
  Topographic features, 15

Geology:

  Stratigraphy, 15
    Rocks not exposed at the surface, 15
    Devonian system, 16
      Chemung formation, 16
      Catskill formation, 16
    Carboniferous system, 18
      Mississippian series, 18
      Pocono formation, 18
        Pocono sandstone or Hundred-foot sand, 18
    Rocks exposed at the surface, 18
        General statement, 19
        Distribution, 19
    Mauch Chunk formation, 19
    Pennsylvania series, 19
      Pottsville formation, 19
        General statement, 19
        Distribution, 20
        Connoquenessing sandstone, 20
        Mercer shales, 20
        Homewood sandstone, 20
      Allegheny formation, 20
        General statement, 20
        Southern segment, 21
          Generalized section in Southern segment of Clarion quadrangle, 21
          Brookville coal, 21
          Clarion coals, 21
          Vanport limestone, 22
          Lower Kittanning coal, 22
          Middle Kittanning coal, 23
          Upper Kittanning coal, 23
          Lower Freeport limestone, 23
          Lower Freeport coal, 22
          Upper Freeport flint clay, 23
          Upper Freeport limestone, 23
          Upper Freeport coal, 24
        Northern segment, 24
          Generalized section of Northern segment of Clarion quadrangle, 24

Page.
        Brookville coal, ... 24
        Clarion coal, ... 24
        Kittanning sandstone, ... 24
        Lower Kittanning clay, ... 25
        Lower Kittanning coal, ... 25
        Middle Kittanning coal, ... 26
        Upper Kittanning coal, ... 26
    Conemaugh formation, ... 26
        General statement, ... 26
        Mahoning sandstone, ... 26
        Mahoning coal, ... 26
Structure, ... 27
  Method of showing structure by maps, ... 27
    Base map, ... 27
    Structure contours, ... 27
    Accuracy of structure contours, ... 28
    Convergence between the Lower Kittanning coal and the Hundred-foot sand, ... 29
  Prominent structural features, ... 29
    Kellersburg anticline, ... 29
    Fairmount syncline, ... 29
    Rimersburg anticline, ... 29
    Bradys Bend syncline, ... 30
    Riedsburg syncline, ... 30
    Clarion syncline, ... 30
Oil and gas pools on the Clarion quadrangle, ... 30
  Elk Township, Clarion County, ... 30
    Elk City pool, ... 31
      Structure, ... 31
  Beaver Township, Clarion County, ... 34
      Structure, ... 35
        Possible location of undeveloped pools, ... 36
  Paint Township, Clarion County, ... 37
      Manor oil pool, ... 37
      Structure, ... 38
      Stratigraphy, ... 38
      Prospective oil and gas territory, ... 39
  Highland Township, Clarion County, ... 39
      Miola oil and gas field, ... 39
      Structure, ... 41
      Stratigraphy, ... 41
  Mill Creek Township, Clarion County, ... 42
  Clarion Township, Clarion County, ... 45
      Clarion oil pools, ... 45
      Structure, ... 47
      Stratigraphy, ... 48
      Possible location of productive territory, ... 50
  Monroe Township, Clarion County, ... 51
      Clarion oil pool, ... 51
      Kifer oil pool, ... 53
      Bittenbender gas pool, ... 56
      Structure, ... 58
      Possible locations of productive territory, ... 58

Page.
Piney Township, Clarion County, ... 58
  Shamburg oil and gas pool, ... 59
  Structure, ... 63
Limestone Township, Clarion County, ... 64
  George gas field, ... 64
  Greenville gas field, ... 65
  Structure, ... 72
Red Bank Township, Clarion County, ... 72
Red Bank and Mahoning Townships, Armstrong County, ... 77
Porter Township, Clarion County, ... 79
  New Bethlehem gas field, ... 79
  Leatherwood gas field, ... 82
  The Piolett gas field, ... 92
  Bittenbender gas field, ... 96
  Structure, ... 98
  Possible location of undeveloped pools, ... 98
Toby Township, Clarion County, ... 100
  Structure, ... 102
Madison Township, Clarion County, ... 103
  Structure, ... 104
  Favorable location for gas pools in Toby and Madison townships, ... 104

LIST OF ILLUSTRATIONS.

Plate. Page.

I. Oil and gas fields of Pennsylvania, ... 15

II. Sections of Deep Wells, ... 16

III. Sections of Deep Wells, ... 16

IV. Map showing oil and gas pools, elevations of wells and structure contours, ...

V. Map showing oil and gas pools, elevations of wells, and structure contours on Lower Kittanning coal and 100 foot sand, ... 31

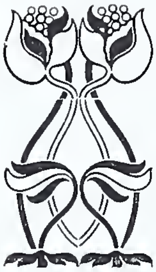
VI. Location of oil and gas pools in the Third and Fourth Sands, ... 45

VII. Location of oil and gas pools in the Bradford, Tiona and Speechley Sands, ... 58

VIII. Location of oil and gas pools in the Murraysville and Hundred-Foot Sands, ... 72

IX. Map of gas fields in Southwest Corner of Clarion Quadrangle, ... 98

Figure 1. Section of Outcropping Rocks, ... 19



LETTER OF TRANSMITTAL.

Hon. George W. McNees, Chairman, and Members of the Topographic and Geologic Survey Commission.

Gentlemen: I have the honor to transmit herewith the manuscript and illustrations of a Report on the Oil and Gas Fields of the Clarion Quadrangle, prepared by Mr. M. J. Munn, and recommend its publication as Report No. 3.

This is the second of a series of detailed reports on the oil and gas resources of Pennsylvania, the first being a report on the Sewickley Quadrangle. The history of the relation of geological research as applied to the oil and gas industry has been one of constant contradiction. At one time it was thought that structure had all to do with the presence of oil in paying quantities. This was in turn disputed, and in some of the earlier reports of the Second Geological Survey we find the statement made that no relation existed between structure and accumulation in paying quantities. During the progress of the Second Survey the fact that most of the oil and gas pools then known were situated on the slopes, and generally near the crests of anticlinal folds was determined, and the "Anticlinal Theory" was developed, largely through the work of Dr. I. C. White, then connected with the Survey. This theory has had the test of time, and while it is now known the folds do not lie in the straight lines shown on the early maps of the anticlinals of western Pennsylvania, and that they are often obscure and are rather a series of "domes," than a continuous structure, yet the underlying principles of the theory have received general acceptance, both by geologists and by practical oil and gas men as well. With the incease of knowledge during the last few years there have come to light some apparent contradictions to the theory, or rather to the theory as defined by some writers, and in the first of this series of reports will be found a short statement of some of these apparent contradictions, as also a statement by Dr. I. C. White of the theory as now held and its special application to the pools and fields of the Sewickley Quadrangle, of which that report treats.

There will not be found in this report, therefore, any theoretical discussion of the theory, or of the apparent contradictory facts brought out in these detailed reports. It is hoped we will be able before long to present a general review of the oil and gas industry and development within the State, which will be the proper place for a general discussion of the various theories of the formation and accumulation of these valuable deposits and their development.

I desire, however, to call special attention to the high character of this report. It has not been possible to attain as great accuracy in this report as in that of the Sewickley Quadrangle. In the case of the latter Quadrangle the developments have been recent, indeed much drilling was still in progress during the time of the field work. In the Clarion Quadrangle, on the other hand, much of the development was older and therefore it was often impossible to obtain records of wells, and when these old records could be had, the location of the particular wells in the field could not always be determined. These difficulties will be at once recognized by those familiar with the history of oil and gas developments. This difficulty in obtaining detailed information only the more shows the necessity of the most careful examination of these old fields at the earliest possible date. The work of the geologists of the Second Survey in the oil and gas region was of a high order, but they did not at that time have the topographic maps which are now available for use, and which really form the basis for any detailed geological work. The relation of the various folds in the surface rocks to those in the underlying rocks was not then fully recognized, nor had the great non-conformity shown to exist in western Pennsylvania, and exposed along the Allegheny valley, been discovered, and therefore the relation of the various oil sands in the fields then developed, and their correlation with other formations, was imperfectly understood.

Pennsylvania has obtained great wealth from the oil and gas industry within its borders, and there is much of great value yet to be obtained, but it will only be by detailed geological work covering the whole of the oil and gas and adjacent regions, similar to that in the Clarion and Sewickley Quadrangles, that this wealth can be obtained without an expense that seems prohibitive.

Very respectfully,
RICHARD R. HICE,
State Geologist.

October 8, 1909.

GEOLOGY OF THE OIL AND GAS FIELDS OF THE CLARION QUADRANGLE.

BY M. J. MUNN.

INTRODUCTION.

This is the second paper of a series to be published on the oil and gas fields of Pennsylvania by the Topographic and Geologic Survey of Pennsylvania and the United States Geological Survey under a co-operative agreement by which each meets half the expense of the work.

The first volume of this series which discusses the oil and gas fields of the Sewickley quadrangle has recently been issued; the third and fourth volumes, discussing the Carnegie and Foxburg quadrangles respectively, are in different stages of completion, and each will be published as soon as it is prepared.

In the paper on the Sewickley quadrangle, the writer inserted a brief theoretical discussion of the origin and causes of accumulations of oil and gas, to be used as a basis for the analysis of such theoretical problems, relative to certain fields, as may arise from time to time during the course of this investigation.

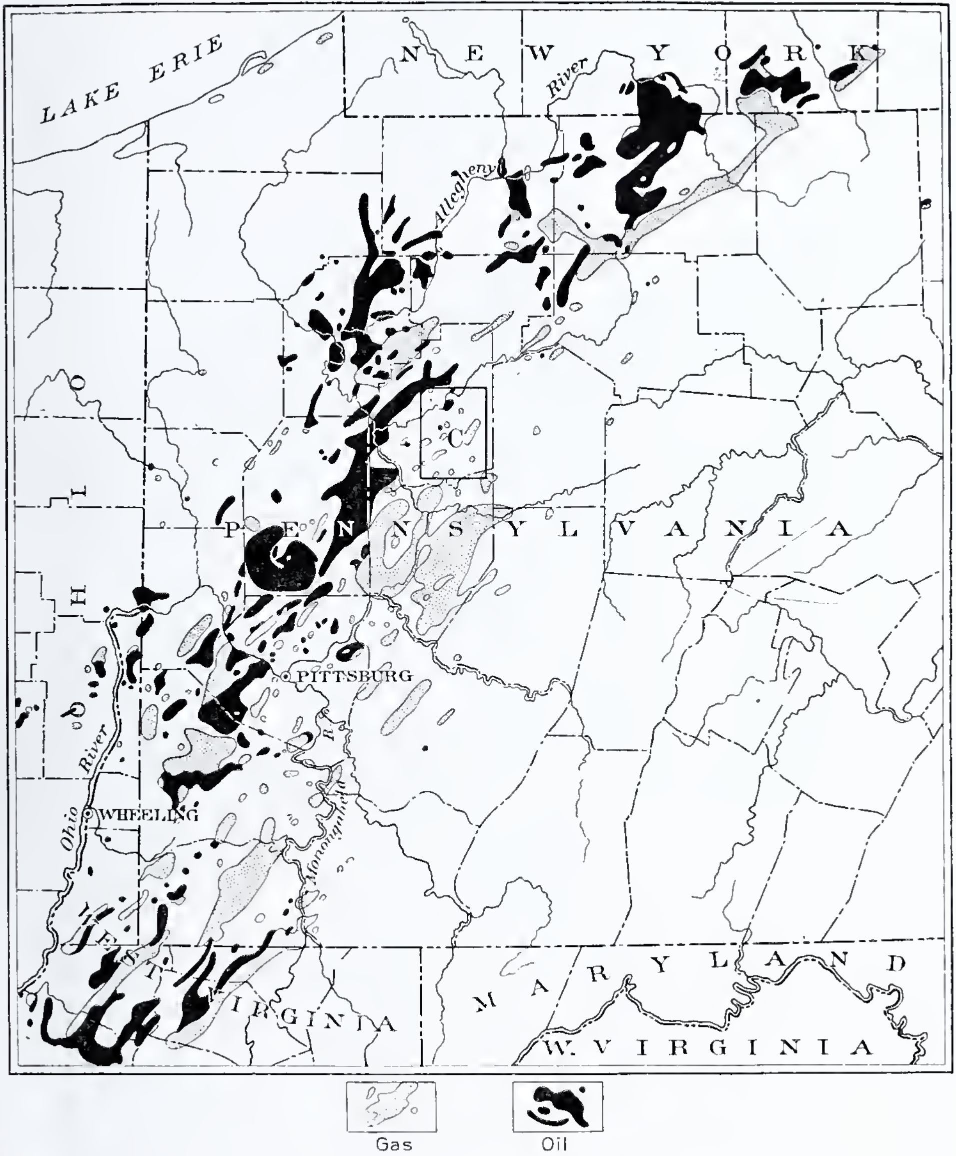
In this, and in future volumes of the series, there will be no need of repeating the general statement and conclusions reached in that discussion, but they will be subjected to such comparisons and revisions as the facts revealed by a study of the fields seem to warrant.

The writer has no preconceived theory of the origin and processes of accumulation of petroleum and natural gas which he wishes to establish to the exclusion of all others. Facts are the first requirement. When these are secured, the theory, whatever it may prove to be, will be evident. Hypotheses are valuable at this stage of the study of oil and gas phenomena only so far as they assist in an intelligent collecting of facts.

The field work for an oil and gas bulletin of the Clarion quadrangle was begun by Mr. W. T. Griswold in 1905 in connection with the making of a topographic map for the U. S. Geological Survey. Under Mr. Griswold's direction, Mr. E. F. Lines, of the U. S. Geological Survey, ran spirit level lines to a large number of oil and gas wells, and obtained the records of many of them from the owners. Circumstances prevented the completion of this field work in 1905. Additional data were collected by Mr. Lines during the season of 1906 while he was engaged in the field work for a folio of this area. No field notes relative to this territory have been furnished by Mr. Griswold. During the month of July, 1907, the writer spent three weeks in a hurried examination of the oil and gas pools of the quadrangle. In this paper an attempt is made to bring together such of the data now available as may be of value, and in doing so the writer waives all responsibility for lack of detailed structural maps of the oil sands, as well as for a more intimate knowledge of the history of the oil and gas pools.

The author wishes to give full credit to Mr. E. F. Lines for the field notes and records of wells collected by him, for the discussion of the stratigraphy of the outcropping rocks incorporated herein, from his manuscript for a folio of this quadrangle, and also for his interpretation of the structure of the surface rocks as shown by contours drawn on the Lower Kittanning coal.

The author wishes also to acknowledge his indebtedness for the courtesies invariably shown him by residents, in answering his inquiries, and to the various oil and gas companies, field superintendents, drillers and pumpers who have furnished assistance and information. Special acknowledgment is made to Mr. N. Johnson, of the Apollo Gas Co., of Pittsburg, Pa.; Mr. F. W. Phillips, of the T. W. Phillips Gas and Oil Co., of Butler, Pa.; Mr. Christy Payne, of the Peoples Natural Gas Co., Pittsburg, Pa., and to Mr. Oliver Culberson, of Clarion, Pa., as well as to the scores of other companies who kindly furnished records of wells and other information regarding them.



MAP SHOWING DISTRIBUTION OF OIL AND GAS FIELDS IN WESTERN PENNSYLVANIA AND ADJACENT TERRITORY

The location of the Clarion quadrangle is shown by the rectangle marked C

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DESCRIPTION OF THE SURFACE.

LOCATION.

The area discussed in this paper is a fifteen-minute quadrangle of the U. S. Geological Survey enclosed by meridians 79° 15′, 79° 30′ and parallels 41° 00′, 41° 15′, which embrace about 227 square miles situated in Clarion and Armstrong counties, Pennsylvania.

TOPOGRAPHIC FEATURES.

This quadrangle lies wholly within the basin of the Allegheny river. Clarion river and Red Bank creek, both tributaries of the Allegheny river, drain respectively the northern and southern portions of the quadrangle. The water-shed dividing the basins of these streams crosses the quadrangle from east to west a short distance south of the centre.

Both Clarion river and Red Bank creek have cut gorge-like trenches from 400 to 600 feet deep across the old and comparatively level surface of the country. The valleys of these streams are almost V-shaped with little or no flood plains, except on Red Bank creek in the southeastern part of the quadrangle where this valley is wider and the hillsides are less abrupt. Tributaries to these streams have steep gradients, with deep, narrow valleys near their mouths. Toward their sources the streams flow through wider, flatter valleys, the adjacent hills being well rounded and suited to agriculture.

GEOLOGY.

STRATIGRAPHY.

The rocks of the Clarion quadrangle are all of sedimentary origin, consisting of shales, sandstones, clays, limestones, coals, etc. These rocks are in successive strata, spread out over greater or less areas. The composition and thickness of each stratum may vary considerably from point to point, because of the differences in the local conditions of the body of water on the bottom of which they were laid down as sediments and afterwards consolidated into rocks as they appear today. Such differences in local conditions are therefore responsible for the variations to be found in the composition and appearance of a given bed from place to place.

ROCKS NOT EXPOSED AT THE SURFACE.

All that has been learned directly of the rocks concealed below the surface on the Clarion quadrangle comes from data obtained in deep holes drilled for oil and gas. This knowledge is augmented by studies made by different geologists of these deeply buried strata at points where they outcrop.

A number of these wells penetrated to a depth of 2,800 to 3,000 feet, which is as much as 2,200 feet below the lowest outcropping stratum within the quadrangle. Few facts could be obtained regarding the geologic age of the rocks at the bottoms of these wells.

A glance at Plates II. and III., which show a number of the more complete records of wells plotted to scale, will give a better idea of this portion of the geologic column than could be gained from pages of description.

In addition to these sections a large number of good records have been published in full in the discussion of the oil and gas pools of the Clarion quadrangle. With these data, only the briefest description of the stratigraphy of the unexposed beds is necessary for the purposes of this paper.

DEVONIAN SYSTEM.

Chemung Formation.

The bottoms of the deeper wells are in what is called the Chemung Formation, the top of which is tentatively placed at the bottom of the lowest red shale. The shales of this formation are said to be previalingly chocolate-colored; the sandstones are usually white or grayish, but are in a few instances reported as reddish. Of the sandstones of this formation, the Speechley is the most uniform in thickness and occurrence. The Tiona and the Second or Lower Bradford sands are also quite persistent, and are nearly always reported in wells sunk to their respective horizons.

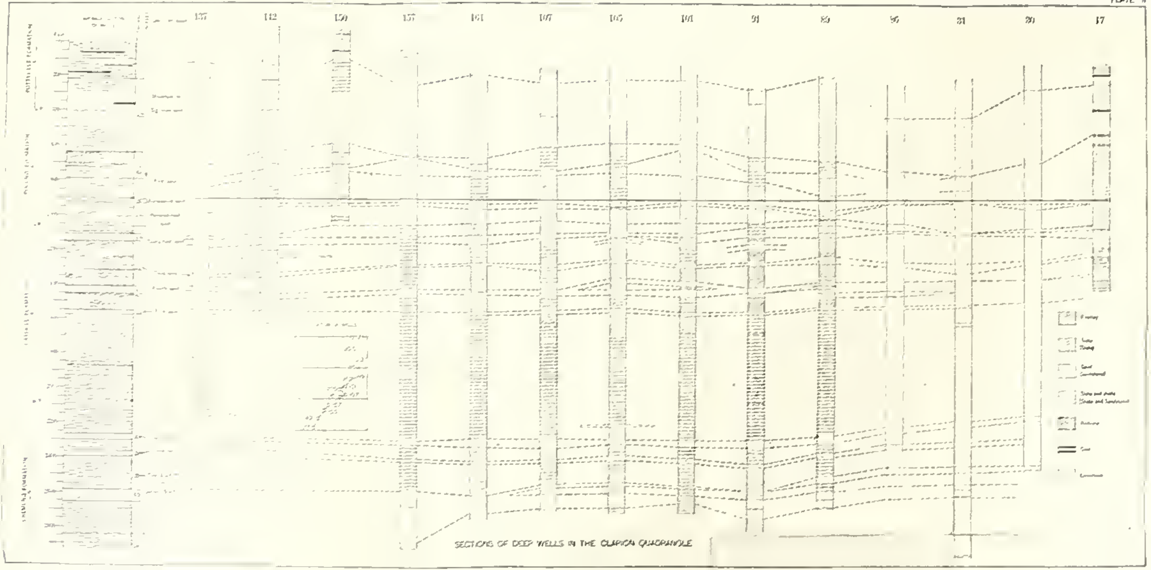
Catskill Formation.

In this quadrangle, the Catskill formation is supposed to embrace about 1,000 feet of rocks overlying the Chemung, up to and including the red bed which is frequently found at the base of the Hundred-foot sand (Pocono sandstone).

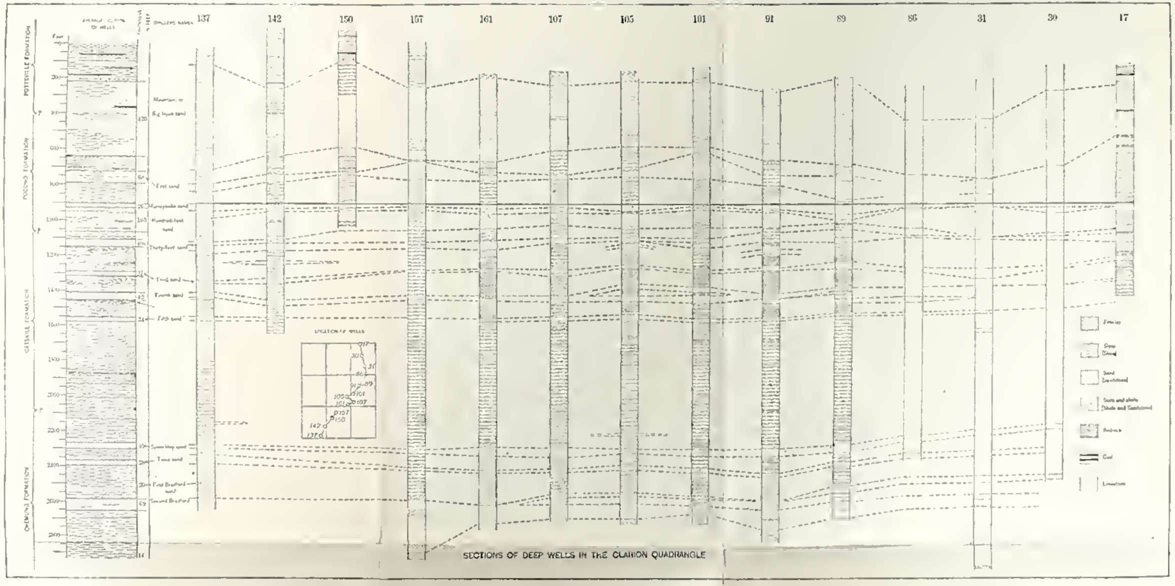
Geologists are not agreed as to what rocks shall be included in the Catskill formation, nor does it appear that any boundary can be set on this formation that will hold over any very large portion of the Appalachian Province. In this paper, it is tentatively assumed that all red shales below the Hundred-foot and above the Speechley sands are to be included in this formation. In the Clarion quadrangle, the lower half of this formation is composed of shale and thin sandstones, called by the drillers "slate and shells." Within this part, a few records mention thin streaks of red rock (shale), and occasionally a sandstone lentil of sufficient thickness to be recognized as a sand.

TOPOGRAPHIC AND GEOLOGIC SURVEY OF PENNSYLVANIA

PLATE II



SECTIONS OF DEEP WELLS IN THE CLARION QUADRANGLE



SECTIONS OF DEEP WELLS IN THE CLARION QUADRANGLE

The upper half of the formation carries several fairly persistent sandstones which are known to drillers as the famous "Venango oil sands." The more prominent sands of this group, in ascending order, are the Fifth, Fourth, Third, and Thirty-foot. These sands are usually separated by greenish or red shales, the latter being called Red Rock by drillers. Occasionally two other sandstones, known as the Stray or Boulder, and the Blue Monday or Snee sand, occupy a portion of the interval between the third and thirty foot sands. In a few wells there seems to have been found two distinct sandstones between the Fifth and Third, instead of a single one (the Fourth), which usually occupies a portion of that interval. It is thought by the writer that these sands are really two members of the Fourth, separated locally by a parting or "break" of sufficient thickness to be noticed by the driller; and he thinks it very probable that in areas where the Third and Fourth sands are reported as bearing oil and gas, the production really comes from members of the same sand, though from the records it is difficult to tell positively whether these sands belong to the horizon of the Third or the Fourth sand. The Fifth sand, which is the lowest of the group, occurs about 700 feet above the Speechley sand and at or near the base of the main body of red shale. Because of its deep, almost blood-red color, this red shale forms conspicuous stratigraphic horizons for drillers, and it may be assumed that all detailed records give the thickness and position of these "Red Rocks" with more than average accuracy. Such records show them to change quite rapidly from well to well within relatively short distances. The thickest bed of red shale is generally considered to separate the Third and Fourth sands, and is called the Big Red Rock. This name is not applied uniformly, however, it being frequently given to the red rock overlying the Third sand horizon, where this portion of the red shales are thickest. This variation in the thickness of the different members of the red shale group is well illustrated in the records shown on Plates II. and III., and it has led to much confusion among drillers relative to the naming of associated sandstones. Over much of this quadrangle the Third and Fourth sands are considered by drillers to be separated by only a very thin bed of red rock or shale of between one and ten feet in thickness, and in a few places these sands are thought to unite and form a single sandstone. By a study of the well records the writer was unable to definitely show that this nomenclature is correct, or that the two sands are in reality members of the same sand as stated above. For this reason he has plotted certain areas as producing from the Third and Fourth sands when it seems probable that one or the other of these sands has developed at those places a local parting (break) of sufficient magnitude to make the two members of the same sand appear to be different sands.

The Venango group of oil sands in the Clarion quadrangle are thickest in the north-west half, gradually thinning towards the east and south-east into the layers of hard sandstone interbedded with shale, which drillers term slate and shells.

CARBONIFEROUS SYSTEM.

MISSISSIPPIAN SERIES.

Pocono Formation.

In the Clarion quadrangle there is no means of definitely determining the division between the Catskill and Pocono formation. There is probably no time break between the deposition of the top of the one and the bottom of the other, and it is believed by geologists that the Catskill formation merged into the Pocono without a break in sedimentation. The Pocono consists principally of sandstones, though a number of thick beds of shale occur somewhat below the middle of the formation.

Pocono Sandstone or Hundred Foot Sand.—This prominent sandstone occurs at or near the bottom of the Pocono formation. It is one of the most widespread sandstones of western Pennsylvania, as well as the greatest oil and gas producer of that region. Recent correlations by Charles Butts (a) seem to show fairly conclusively that this sandstone is the same as the Berea sandstone of northern Ohio. The Berea has heretofore been considered by drillers in Beaver, and portions of Allegheny, Washington, and Lawrence counties, to be equivalent to the First sand above the Murrysville, which overlies the Hundred foot.

More geologic work is needed in Butler, Lawrence and Venango counties, to definitely settle this point. For over 300 feet above the Hundred foot sand the rocks are prevailingly shaly; though two persistent sandstones, known locally to drillers as the Murrysville and First sands, occupy portions of this interval. The average distances of the top of these sands above the Hundred-foot are 50 and 225, respectively. Their average thickness in the records examined are 26 and 68 feet, respectively. Above the First sand a bed of red shale, with a maximum thickness of less than 20 feet, is noted in a few well records. The greenish to reddish shales at the top of this interval outcrop in a few places, and are therefore to be considered under the following heading:

Rocks Exposed at the Surface.

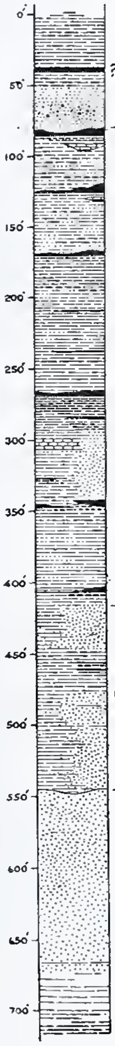
No study was made by the writer of the outcropping rocks within the Clarion quadrangle in the brief time he was engaged in the field work for this bulletin. This work was done by Mr. E. F. Lines, (b) from whose paper the following (c) extract is taken.

(a) Report of Progress on Geologic work under the Topographic and Geologic Survey Commission of Pennsylvania. Annual Report 1906-1908., p. 190.

(b) Pocono Formation.

(c) Geologic Atlas, Folio No. U. S. Geol. Survey.

Fig I Generalized Section of the Outcropping Rocks On the Clarion Quadrangle.

SYSTEM	SERIES	FORMATION NAME	SYMBOL	COLUMNAR SECTION	THICKNESS IN FEET	NAMES OF MEMBERS	CHARACTER AND DISTRIBUTION OF MEMBERS
CARBONIFEROUS	PENNSYLVANIAN	CONEMAUGH FORMATION		 0' 50' 100' 150' 200' 250' 300' 350' 400' 450' 500' 550' 600' 650' 700'	? 4' 80' +	Mahoning coal	4' thick Occurs only in one or two hilltops in the southwest corner of the quadrangle
						Mahoning sandstone	About 30' thick. Massive and conglomeratic Caps a number of hills in the south half of the quadrangle
		ALLEGHENY FORMATION			3½-5½	Upper Freeport coal	3½ to 5½' thick. Occurs only in a few hilltops in south half of the quadrangle. Underlain by unimportant lenses of flint clay and limestone
					3-7½	Lower Freeport coal	From 3' to 7½' thick in the southeast corner of the quadrangle, elsewhere thin and unimportant
					2'-4'	Upper Kittanning coal	From 2' to 2½' thick and poor in quality, except north of New Bethlehem where it is 4' thick and of excellent quality
					300'-350'		
						Middle Kittanning coals	Thin and unimportant. Probably lenticular and in more than one horizon.
					2'-4½' ½'-2	Lower Kittanning coal Plastic clay Coal Flint clay	From 2' to 4½' thick of good quality and present over most of the quadrangle. Underlain by 5' to 10' of plastic clay. In the vicinity of Clarion River a coal seam ½' to 2' thick occurs from 4' to 17' below the Lower Kittanning. This seam is underlain by 0' to 6' of flint clay which is locally of good quality
					0'-8'	Freeport limestone	Gray fossiliferous limestone 0' to 8' thick overlain by thin bed of iron ore Generally present south of Piney Creek replaced by sandstone north of the creek
					0'-4'	Clarion coals	Probably lenticular and at more than one horizon Generally thin and unimportant in areas in which limestone is present. 4' thick and of fair quality immediately below sandstone when limestone is absent
					0'-4½'	Brookville coal	Thin and worthless over most of quadrangle. 4½' thick but poor in quality in northeast corner
		POTTSVILLE FORMATION				Homewood sandstone	Coarse gray heavy sandstone about 40' thick on Redbank Creek where it is typically developed.
						Mercer coals	Thin and worthless. Possibly accompanied locally by valuable flint clay
					125'-150'		
						Connoquinnessing sandstone	Gray heavy bedded sandstone
	MISSISSIPPIAN	POCONO FORMATION			170 +	Burgoon sandstone	

General Statement.—The lowest rocks exposed in the quadrangle belong to the Pocono formation, the uppermost member of the Mississippian series. Most of the portion of the formation that is exposed in the quadrangle is composed of a gray, coarse-grained massive sandstone, known to drillers as the "Mountain" or "Big Injun" sand. In the Kittanning folio this sandstone is named "Burgoon" by Butts, who then discusses the reasons for assigning this member to the Pocono formation. The limited exposures of the Burgoon standstone in the Clarion quadrangle indicate a thickness of 120 feet or more. Boulders from this sandstone on the north side of Clarion River, opposite Clarion, are 15 or 20 feet in diameter. At various points in the bottom of Clarion River gorge partial exposures are visible of the shales below the sandstone. The best exposures of these shales is opposite the mouth of Piney Creek, where a 30-foot cliff below the sandstone reveals alternating bands of greenish shale and flaggy sandstone.

Distribution.—The Pocono formation outcrops in the quadrangle as a narrow band in the ravines of Clarion River, Deer Creek, Foly Creek and Mill Creek throughout their length in the quadrangle and up Piney Creek for four miles from its mouth. The formation also outcrops in Red Bank Creek where it bends into the quadrangle at Leatherwood Station and for a distance of one mile up Leatherwood Creek.

Mauch Chunk Formation.

The Mauch Chunk formation is not present in the quadrangle. Its absence is associated with a nonconformity between the Pocono and Pottsville formations.

PENNSYLVANIA SERIES.

Pottsville Formation.

General Statement.—Although the Mauch Chunk formation has been eroded from this area and the lowest Pottsville rocks lie unconformably on the Pocono, the line of separation is not lithologically clear because massive sandstones occur both at the top of the Pocono and at the bottom of the Pottsville.

In the Kittanning and Rural Valley quadrangles, a division between the Pottsville and Pocono, based mainly on fossil evidence, is made at a distance of 230 feet below the Vanport limestone, and this limit is applied throughout these two quadrangles. In the Clarion quadrangle, the same limit is used in the portion adjacent to the Rural Valley quadrangle, but in the Clarion River region a slight modification is made on lithologic grounds. In the first lateral ravine above the mouth of Piney Creek, on the south side of the Creek, is a 120-foot exposure of the Burgoon sandstone which is apparently a lithologic unit. The top of this exposure is 275 feet below the Lower Kittanning coal, or about 15 feet higher than the upper limit of the Pocono assigned by Butts in Kittanning and Rural Valley quadrangles. Throughout the northern portion of the quadrangle, therefore, the writer has mapped the base of the Pottsville 275 feet below the Lower Kittanning coal. The upper limit of the Pottsville is marked by the Homewood sandstone, the top of which is from 100 to 135 feet below the Lower Kittanning coal.

Distribution.—In the southern portion of the quadrangle, the Pottsville formation outcrops in Wild Cat Run up to a point about one-quarter of a mile north of Wild Cat, as a narrow band above the Pocono in the bend of Red Bank Creek, above the Pocono on Leatherwood Run and as far north as Rockville, about two miles up Long Run and on either side of Red Bank Creek east of Hawthorn and up Pine Creek to the eastern edge of the quadrangle.

In the central portion of the quadrangle, the Pottsville outcrops as a narrow band on Licking Creek up to a point about two miles above Curllsville and in Piney Creek Valley and its tributaries as a band from one-half to one mile or more in breadth. On the axis of the Millersburg anticline, it reaches up the hillsides to an altitude of 1,550 feet or more. In the northern portion of the quadrangle the Pottsville outcrops as a narrow band above the Pocono in the gorges of Clarion River and its tributaries, except on Douglass Run, where it extends about two miles above where the Pocono passes below drainage.

Connoquenessing Sandstone.—The Connoquenessing sandstone, the lowest member of the Pottsville formation in this area is a coarse-grained, massive sandstone very similar to the Burgoon sandstone of the Pocono formation. This sandstone was identified by Butts in the vicinity of Leatherwood, but in the northern portion of the quadrangle the writer found no good exposure of it.

Mercer Shales.—In the midst of the Pottsville formation there is a series of shales, thin coals, and clays, which have received the name Mercer because in Mercer county one of the coals is worked. This horizon is chiefly important because it contains in some places a valuable refractory clay. Good exposures of the Mercer horizon are rare in the Clarion quadrangle because of its position between two heavy sandstones. The best exposure is in the railroad cut one-half mile west of Mayport, where the section shows 20 feet of shale in which are two thin seams of coal.

Homewood Sandstone.—The Homewood sandstone, the topmost member of the Pottsville, is a coarse-grained, massive sandstone, averaging about 40 feet in thickness. This sandstone makes a number of flats and benches in the southern part of the quadrangle. The best exposure is above the Pennsylvania Railroad track between Hawthorn and Mayport, where practically the entire thickness of the sandstone is exposed in the cliff. Another good exposure of the sandstone is on the Sligo Branch of the Pennsylvania Railroad in the Valley of Wild Cat Run. In the northern part of the quadrangle, the Homewood sandstone is well developed but not noticeable in outcrop, for the reason that it lies between other equally heavy sandstones.

Allegheny Formation.

General Statement.—The Allegheny formation is composed of a series of sandstones and shales interbedded with coal, clay and limestone. In this formation coarse sandstones are much less prominent than in the lower formations. The Allegheny formation extends from the top of the Homewood sandstone to the top of the Upper Freeport coal and in some localities no heavy sandstones occur in the whole interval. It is not possible to make a tabular section of the Allegheny formation which will apply over the whole of the quadrangle, because in the lower portion of the series of rocks the conditions are radically different in certain portions of the area from what they are in others. Roughly, a line drawn from a point about one mile north of Sligo on the western edge of the quadrangle through Reidsburg, Mechanicsville, across the pike one-half mile west of Day and to the north edge where Stroup Run enters the quadrangle divides the quadrangle into two areas which have a distinctly different succession of rocks. Because of this variation, the Allegheny formation of the two portions of the quadrangle will be described separately. For conveninece the portion south of the line described will be referred to as the southern segment and the remaining portion as the northern segment.

Southern Segment.

A generalized section of the southern segment of the quadrangle is as follows:

Generalized Section in Southern Segment of Clarion Quadrangle.

	Feet.
Upper Freeport coal,	4½
Clay and limestone lenses,	5
Sandstone and shale,	35
Lower Freeport coal,	5
Clay and limestone lenses,	5
Sandstone and shale,	35
Upper Kittanning coal,	2½
Sandstone and shale,	30
Thin coal,	
Sandstone and shale,	30
Thin coal,	
Sandstone and shale,	35
Lower Kittanning coal,	3
Clay and shale,	25
Vanport limestone,	7
Sandstone and shale with iron concealed,	25
Thin coal,	
Clay and shale,	20
Thin coal locally workable,	
Clay and shale,	50
Brookville coal,	3
Clay and shale,	10

Brookville Coal.—Lying above the Homewood sandstone and separated from it by a few feet of clay, or clay and shale, is the Brookville coal. This seam is thin and worthless over most of the area, but in the northeastern portion it reaches a thickness of 4½ feet. The interval between the Brookville and the next higher coal is occupied by shale and clay.

Clarion Coals.—About 50 feet above the Brookville coal, and from 45 to 60 feet below the Vanport limestone is a coal seam which over most of the region is too thin to work, but at Sligo is three feet thick and mined commercially. As coal fragments and occasional roadside blossoms indicate that there is probably a thin coal from 10 to 20 feet above this one, it is possible that this coal may be the lower split of the Clarion described by Chance (Second Geological Survey of Pennsylvania, Vol. VV, pp. 49-52). The Clarion sandstone which, in some regions, is massive is not developed here. Most of the interval between the Clarion coal and Vanport limestone is occupied by dark drab shale which contains numerous iron nodules. Immediately below the Vanport limestone occurs a coarse sandstone which in most places is only one or two feet thick, but locally becomes massive. The greatest development of this sandstone is at Rockville, where, below the road running north from the village, it forms a cliff 30 feet high.

Vanport Limestone.—The Vanport limestone, sometimes designated "Ferriferous limestone" is one of the most persistent and best known horizons in western Pennsylvania. Wherever it outcrops, it is a valuable key rock for identifying adjoining horizons, or for determining the positions of oil and gas sands.

In quality the Vanport limestone is very pure, an average analysis showing nearly 95 per cent. carbonate of lime with little magnesia. The rock is dark gray in color and fossiliferous. Brachiopods and fragments of crinoid stems are abundant, but corals, pelecypods and gastropods are found in the limestone also. All of these fossils indicate that it is of marine origin. The average thickness of the limestone in Clarion quadrangle is probably about 7 feet. Drillers reported 10 feet of limestone in places, but none of the sections noted in quarries exceeded eight feet. None of the limestone occurs as a solid, unbroken mass. It is usually broken both horizontally and vertically by seams, which, when under light cover cause the limestone to weather into large boulders. The limestone usually contains near or at the top a band of chert about one foot thick. This chert, because of its resistance to weathering frequently indicates the horizon of the limestone when the limestone itself cannot be seen.

Immediately above the limestone is a layer of iron ore that usually occurs as a thin bed of siderite or limonite. The cherty layer which is usually present between the ore and the limestone has given the former the name "Buhrstone ore," a term frequently used in Pennsylvania. Sections in limestone quarries reveal only a few inches of the ore.

In a small area in the vicinity of Blair schoolhouse in the southern part of the quadrangle there is a massive sandstone overlying the iron ore, but elsewhere the interval between the Vanport limestone and Lower Kittanning coal is occupied by sandy shale and thin beds of sandstone.

Lower Kittanning Coal.—The Lower Kittanning coal usually lies about 25 feet above the Vanport limestone, but the interval varies from 10 to 50 feet. The 10-foot interval is doubtful because in the only place where that measurement was made there were two small coal blossoms within the usual interval and the lower one may have been a local deposit that was not a part of the Lower Kittanning seam. The 50-foot interval, however, prevails over considerable areas. This interval occurs in the vicinity of Brinkerton and east of Curllsville.

The Lower Kittanning coal is the most persistent and uniform stratum in the quadrangle. Where it is mined it seldom varies more than 3 feet in thickness. Overlying the coal is usually 20 to 30 feet of black shale sometimes fissile, and usually stained reddish-brown with iron.

In a belt several miles wide extending from Leatherwood to Reidsburg and Mechanicsville, there are no openings nor good blossoms on the Lower Kittanning, and the fact that on the edges of this belt there are several openings in which the coal is only two feet thick indicates a thinning out of coal in this region.

Middle Kittanning Coal—The older surveys have assigned three coals to the Kittanning series, which have been designated Lower, Middle and Upper Kittanning. In Clarion quadrangle, however, it is evident that this succession does not hold. In the road section (Fig. 3) (a) on the west side of Squirrel Hill, this interval contains four coals, and elsewhere, although the whole series is not exposed at one place, the intervals suggest the presence generally of four coals. As the interval to the third coal above the Lower Kittanning is usually about 80 or 90 feet, it seems probable that this is the Upper Kittanning and that the intermediate interval contains two coals instead of the one that is termed the Middle Kittanning. The first coal is usually about 35 feet above the Lower Kittanning, the usual interval between Lower and Middle Kittanning. There appears therefore to be an extra coal between the Middle and Upper Kittanning. The elevations obtained on this coal showed it to be about 65 feet above the Lower Kittanning. Both the Middle Kittanning coals are thin and frequently one or the other appears to be missing. In passing upward through this series, the shale becomes more sandy toward the top.

Upper Kittanning Coal.—The Upper Kittanning coal lies from 70 to 130 feet above the Lower Kittanning. The usual interval is about 80 or 90 feet, but in a limited area southwest of Truittsburg it reaches 130 feet. This coal is much more persistent than the two below, but it is usually thin and dirty. Above the coal the beds are prevailingly medium-grained or shaly sandstone.

Lower Freeport Limestone.—On Myers Hill, southeast of Sligo and on Squirrel Hill fragments of limestone along the roadside indicate local developments of the Lower Freeport limestone. It is not known to occur elsewhere.

Lower Freeport Coal.—The Lower Freeport coal is from 130 feet to 180 feet above the Lower Kittanning. This coal is present to a limited extent near the tops of the hills in the south, and where it has been opened it is thick.

Upper Freeport Flint Clay.—Fragments of flint clay in the roadsides in several places indicate the presence of a flint clay horizon below the Upper Freeport coal. The clay, however, is probably of very local development.

The Upper Freeport Limestone.—The limestone below the Upper Freeport coal is irregular in occurrence. It is present in Myers Hill, in Squirrel Hill, in the hill southwest of Greenville and is reported to have been dug in one or two other places, but the deposits are of small extent.

Upper Freeport Coal.—The interval between the Lower Kittanning and Upper Freeport coal is usually about 200 feet, but varies between 170 and 215 feet. It is worked in the hills in the vicinity of New Bethlehem, in the top of a hill one and one-half miles north of Brinkerton and in Myers Hill. Chestnut Ridge should contain this seam, but the coal has not been found there in workable thickness.

(a) U. S. Geol. Survey, Folio not yet issued.

Northern Segment.

The following general section gives the character and relationships of the rocks of the Allegheny formation in the northern segment of the quadrangle:

Generalized Section of Northern Segment of Clarion Quadrangle.

	Feet.
Fine-grained, flaggy sandstone,	20
Upper Kittanning coal,	1½
Shaly sandstone and shale,	45
Coal,	1
Shale and clay,	28
Lower Kittanning coal,	3
Plastic clay,	10
Coal,	1½
Plastic and flint clay,	5
Coarse pink and gray sandstone,	60
Clarion coal,	3½
Sandstone and shale,	50
Brookville coal,	2½
Shale with sandy layers,	25

Brookville Coal.—The Brookville coal in this segment of the quadrangle s thin and difficult to trace Where identified, it seems to be an unusual distance amounting to 50 feet above the Homewood sandstone. The seam varies from a bituminous shale to shaly cannel and hard, sulphurous coal.

Clarion Coals.—Above the Brookville coal is an interval of 35 to 55 feet filled with sandstone and shale, at the top of which is the Clarion coal. The coal ranges from 2½ to 4 feet in thickness and persists over nearly all the northern part of the quadrangle.

This bed may possibly be correlated with the coal mined at Sligo, but such a correlation is doubtful. Both are evidently members of the Clarion series, but in the northern segment the interval between this coal and the Lower Kittanning is about 20 feet less and is composed of a radically different series of rocks, and for that reason the writer is inclined to consider the beds lenticular.

Kittanning Sandstone.—Immediately above the Clarion coal lies in most of the region a massive, coarse-grained, pinkish sandstone about 60 feet thick. This sandstone is a prominent feature in the topography of the northern part of the quadrangle. Over considerable portions of the area the softer rocks above have been eroded and the heavy sandstone forms extensive flat uplands. The town of Clarion rests upon this sandstone and the long, nearly level stretches of the pike running east from Clarion also rest on the sandstone. The pinkish color of the sandstone distinguishes it readily from the white and gray sandstone of the lower horizons.

In the extreme northwest corner of the quadrangle, the Kittanning sandstone is absent and the intervil is occupied by clay and shale and a number of thin seams of coal. A road section one mile southwest of Shippensville reveals the following succession:

Road Section One Mile Southwest of Shippensville.

		Feet.
1.	Coal blossom,	
2.	Plastic with fragments of flint clay,	
3.	Concealed,	35
4.	Coal blossom,	
5.	Reddish brown shale,	20
6.	Coal,	1
7.	Gray clay,	5
8.	Red shale containing iron concretions,	25
9.	Coal,	1
10.	Clay, clay sandstone and sandy shale,	11
11.	Coal in streaks 1 inch or less in thickness,	
12.	Red shale,	18
13.	Shaly coal,	2
14.	Clay and sandy shale,	10
15.	Coal,	½
16.	Clay,	½
17.	Coal,	1
18.	Reddish sandy shale,	8
19.	Coal,	1½

No. 1 of the section is Lower Kittanning coal and No. 19 is probably the horizon of the Brookville.

Lower Kittanning Clay.—Immediately above the sandstone lies the Lower Kittanning flint clay. This clay is very persistent in the hills that are high enough to catch it. Over most of the northern portion of the quadrangle it varies in quality from a good grade refractory clay to an impure and worthless deposit. The best clay is yellowish brown in color, fine-grained and moderately hard Weathered pieces are bluish gray on exposed surfaces. In places where the clay has been used it ranges from three to four feet in thickness. Immediately above the flint clay and occupying the interval to the coal above is a deposit of plastic clay. The plastic clay is usually thicker than the flint clay and in places entirely replaces it.

Lower Kittanning Coal.—The coal that immediately overlies the clay just described averages, south of Clarion River, about 18 inches in thickness and is separated from the seam usually worked as Lower Kittanning by from 4 to 17 feet of clay. Whether this 18-inch bed should be considered a lower bench of the Lower Kittanning, or a separate seam is somewhat uncertain, but since there is no consistent evidence of the growth of a split and since the position or thickness of the lower bed seems to have no modifying effect on the main seam, it is probable that the lower bed is independent of the upper.

North of Clarion River the presence of two coals at the Lower Kittanning horizon is not evident. The only section revealing two coals above the flint clay is on the pike just west of Clarion Junction. The interval here, however, is 28 feet, the usual interval between the Lower and Middle Kittanning coals. As the intervals to the lower formations are consistent with the lower of these coals, rather than the upper, the lower coal only is assigned to the Lower Kittanning horizon.

Middle Kittanning Coal.—The only indication of the Middle Kittanning coal in this segment is a blossom on the pike west of Clarion Junction described in the preceding paragraph.

Upper Kittanning Coal.—With the exception of the one Middle Kittanning blossom already referred to, the interval of from 65 to 85 feet above the Lower Kittanning coal is occupied by a reddish shale at the top of which is a thin coal seam. This bed has not been worked, but it is reported to be about 18 inches thick. The coal shows in a spring on the hill above the Baldof No. 1 mine, two miles southeast of Strattonville. A shaly sandstone overlies the coal and forms the uppermost rock in the northern segment of the quadrangle.

Conemaugh Formation.

General Statement.—Only the lowest members of the Conemaugh formation are present in the Clarion quadrangle and these are confined to the highest hills in the southern portion of the quadrangle.

Mahoning Sandstone.—The Mahoning sandstone usually lies directly upon the Upper Freeport coal, but in some places there are a few feet of shale intervening. When the sandstone is typically developed, it is massive and conglomeratic. It is difficult to determine the thickness of the sandstone because it occupies the tops of the hills and is usually much eroded and disintegrated. Where this sandstone caps the range of hills two miles west of New Bethlehem, its presence is indicated only by fragments of conglomerate that are scattered over the hillsides. The top of the highest of these hills rises 70 feet above the Upper Freeport coal. As there are no large boulders on this hillside, it is probable that the Mahoning sandstone here is not massive. The massive character of the sandstone is best shown on a hill two and one-half miles west of Greenville and one and one-half miles east of Sharpsburg Church, where the summit of the hill just catches the sandstone and over about an acre there rests a pile of huge boulders 10 to 20 feet in diameter. The rocks are nearly enough in place to estimate that the thickness of the stratum represented is about 30 feet. There is a considerable area of Mahoning sandstone on Chestnut Ridge and here the sandstone is 40 or 50 feet thick. The only other areas occupied by the Mahoning sandstone are occasional hilltops in the southern portion of the quadrangle.

Mahoning Coal. In two of the highest knobs on Chestnut Ridge at an interval of about 50 feet above what was considered the Upper Freeport Coal occurs a four foot coal which may be at the Mahoning coal horizon. The fact that a four foot coal supposed to be at this same horizon just west of the quadrangle near Rimersburg has proved to be Upper Freeport raises a question as to the stratagraphic position of this coal. The coal has been opened under a cover of 40 feet of shale in one of the knobs. This coal occurs nowhere else in the quadrangle."

The above quotation does not include Mr. Lines' discussion of certain terrace deposits along some of the streams of Clarion quadrangle, as these deposits have no connection with the oil and gas bearing beds of this area, and are of no value in studying the geology of those accumulations.

Structure.

Since the rocks described above were laid down stratum upon stratum as sediments on the bottom of the sea, the whole mass has been many times slowly raised and depressed by deep-seated and widespread movements within the earth's crust. The last great movement was upward and of sufficient magnitude to lift those strata to their present height. This process was very slow and continued over a very long period of time, and from what is known may still be going on. In the course of this uplift the beds were subjected to many strains and stresses which resulted locally in a certain amount of wrinkling of the comparatively smooth strata into gentle folds, and regionally in a slight tilting of the whole rock mass to the south and southwest. The pressure was exerted in such directions as to develop major folds having a general northeast-southwest trend, and also a tendency towards the development of a secondary system of minor folds having a southeast-northwest trend. It is not positively determined which of these systems of folds were formed first, the latter, however, is only of sufficient magnitude to cause slight changes in the height and depth of the major folds from point to point.

By structure is meant the present shape or lay of the beds. In describing structure an upward bending fold or arch is called an anticline, and a downward bending trough a syncline. Low places in a syncline are sometimes designated as basins; high points along the crests of anticlines form domes. The axis of a fold is that line which passes through the highest points along the crest of an anticline, or the lowest points along the trough of a syncline.

Method of Showing Structure by Maps.

Base Map.—It is evident that in order to accurately show the position of the structural features of an area the geologist must have as a base an accurate map of the surface. Such a map of the Clarion quadrangle has been made by the Topographic Branch of the U. S. Geological Survey, on the scale of 1-62500, or approximately one inch to one mile. On this topographic map are shown all surface features of sufficient size to appear on this scale, such as towns, railroads, roads, trails, houses, streams, hills, valleys, etc. These maps are printed in three colors: brown, blue and black, as may be noted by an examination of Plate IV.

Structure Contours.—In areas where the rocks have been subjected to slight folding, as in the Clarion quadrangle, the best means of depicting their structure is by contour lines drawn on the top or bottom of some well known bed called the key rock, of which the altitude above or below sea level may be determined at a sufficient number of points. Contour lines are drawn through points of equal height around the sides of the anticlines and synclines, and represent level lines of an equal vertical distance apart. On Plate IV the structure is represented by contours on the Lower Kittanning coal having an interval of 25 feet. In Plate V the black contours are on the above horizon, those in green being on the top of the Hundred foot sand. Those on Plate IX are on the top of the Hundred foot sand and have a contour interval of only 10 feet.

Accuracy of Structure Contours.—The structure contours on the Lower Kittanning coal as shown on Plates IV and V were drawn by Mr. Lines, who discusses their accuracy as follows:

> "The accuracy of the structure contours depends upon three factors: First, the accuracy of the elevations obtained directly; second, the difference between the actual interval when the elevation of the key rock is calculated from an observation on some other rock, and the interval that is assumed; and third, the number and distribution of the elevations. In the Clarion quadrangle, the elevations of practically all coal outcrops, mines and country banks were obtained with a spirit level, so that the limit of error for the first factor is small, probably in most places less than two feet. The limit of error for the second factor is much larger, because the different strata are not parallel and the distance between the unknown and the nearest known intervals was in most cases sufficient to permit considerable variation. The possible errors under the third condition vary in different areas. Over nearly all of the quadrangle south of Piney Creek elevations on well marked horizons are numerous and well-distributed, but north of the creek such elevations are comparatively few. This is especially true of the northeast and northwest corners of the quadrangle. When all these possibilities of error have been allowed for, it is assumed that the structure contours are correct within a contour interval, therefore, in Clarion quadrangle the position of each contour line is thought to be in error less than 25 feet. In the region between Day and Kingsville, the data are too meagre to indicate the position of the contours within a contour interval, therefore the approximate positions are shown by dotted lines."

What has been said above regarding the accuracy of the contours on the Lower Kittanning coal is in a measure applicable to those drawn on the Hundred-foot sand, as shown on Plate V. The actual elevation above sea-level of the top of this sand was found by running spirit-level lines to the mouths of the wells and deducting from the elevation thus obtained the distance down to the sand as shown by steel line measurements. The actual elevation of the sand at the wells is shown by the numbers attached to wells. This is also true of the set of larger numbers on Plate IX. On the latter plate the set of smaller numbers refer to the numbers of wells under which they are discussed in chapter on the oil and gas fields of the Clarion quadrangle. From these data the reader can get a fair idea of the accuracy of the structure contours on the Hundred-foot sand in any part of the Clarion quadrangle over which they are drawn.

Convergence Between the Lower Kittanning Coal and the Hundred Foot Sand.—By an examination of Plate V it will be seen that the black and the green structure contours do not coincide, and that the folds which each depict in the coal and the sandstone, respectively, are not superimposed as might be expected. This is due to the fact that the two beds do not lie exactly parallel over even relatively small areas, which is caused by unequal deposition of sediments in different areas when the intervening beds were being formed. The actual convergence of the two horizons is also probably considerably exaggerated by the contours, due to the unequal distribution of elevations on the two beds, and to the personal equasion envolved in drawing the contours.

Prominent Structural Features.

Kellersburg Anticline.—The most prominent structural feature of the Clarion quadrangle is the Kellersburg anticline which cuts the southern border about half way between New Bethlehem and Leatherwood station. The axis of this fold in the Lower Kittanning coal passes about half a mile east of Jacks School House, the same distance east of Frogtown, somewhat more than a mile east of Greenville and half a mile west of Rader, and leaves the eastern border near the northern boundary of Limestone township. The axis of this fold in the Hundred foot sand seems to lie somewhat farther to the west and parallel to the one in the coal. The crest of this arch in both beds is lowest at a point northwest of New Bethlehem from which it rises between 50 and 75 feet to the southern border of the quadrangle. Northward from this point the crest lies almost level for two miles, from which point it rises 150 feet to a point one-half mile south of Frogtown, thence northward the crest rises only 25 feet to a mile northeast of Frogtown, but at a point a mile northeast of Pine Grove schoolhouse the rocks are 150 feet higher. Continuing northeast the axis of the anticline traverses the crest of a dome which raises the rocks to the highest elevation within the quadrangle.

Fairmount Snycline.—The axis of this syncline cuts the southern border of the quadrangle south of Fairmount with a north-northeast trend, and leaves the eastern border northeast of Truittsburg. Within this distance the bottom of the trough rises more than 250 feet. From the axis of this trough at Fairmount the rock rises over 300 feet to the lowest point in the Kellersburg anticline northwest of New Bethlehem.

Rimersburg Anticline—In the southwestern part of Limestone township a secondary anticlinal fold juts out to the southwest from the flank of the Kellersburg naticline. The axis of this fold, which has tentativly been named by the writer the Rimersburg anticline, leaves the western edge of the quadrangle about a mile south of that village. On

Plate V the axis of this fold, as shown by the black and the green contours, do not coincide. It is possible that this variation is due mainly to lack of data on the Hundred foot sand for the green contours.

Brady's Bend Syncline.—This trough lies between the Kellersburg and Rimersburg anticlines, with its northern end in the southwest corner of Limestone township. From this point the axis of the syncline pitches southward to the vicinity of Rockville, thence southwestward in sinuous curves to where it leaves the quadrangle near the southwest corner. This syncline is discussed more fully under Porter and Madison townships.

Reidsburg Syncline.—This lies west of the Rimersburg and Kellersburg anticlines, and forms a broad shallow trough, the axis of which crosses the quadrangle from the vicinity of Sligo on the western border; passes northeastward through Reidsburg in Monroe township, a mile west of both Mechanicsburg and Strattonville, thence northward to the edge of the quadrangle, a mile or more east of Miola. In this distance the bottom of the trough rises more than 250 feet.

Clarion Syncline.—From the northern portion of Monroe township in the vicinity of Williamsburg a secondary trough branches off from the Reidsburg snycline in a northwest direction, the axis of which crosses the Clarion river west of Clarion, and leaves the northern border of the quadrangle a mile or more west of Shippensville. In the Lower Kittanning coal this trough is broad and flat, at no point rising more than 75 feet above the bottom of the Reidsburg syncline at the junction of the two depressions.

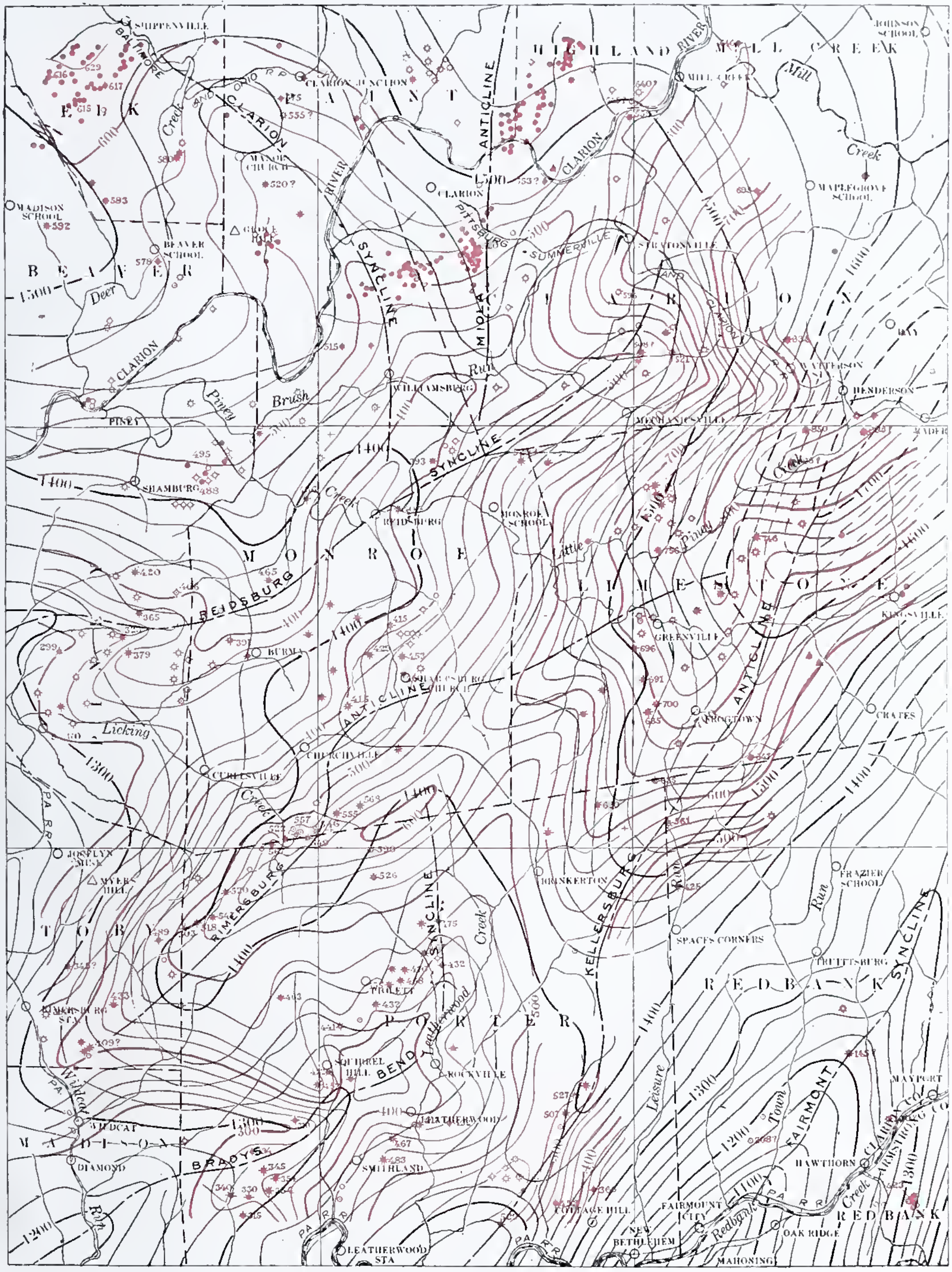
Miola Anticline.—This is a name given by the writer to a small anticlinal nose which projects southward between the Reidsburg and Clarion synclines from the northern edge of the quadrangle west of Miola to Brush Run south of Clarion, where it disappears near the junction of the above synclines.

By an examination of Plate V it will be seen that in the northwest half of the quadrangle the contours as drawn on the Hundred foot sand show considerable variance from those of the Lower Kittanning coal. This is especially noticeable in the pitch of the axis of the Clarion syncline, and in the secondary trough in the vicinity of Watterson station. The minor structural features of the quadrangle will be discussed in more detail by townships.

OIL AND GAS POOLS ON THE CLARION QUADRANGLE.

ELK TOWNSHIP, CLARION COUNTY.

Only that portion of Elk township which is embraced by the northwest corner of the quadrangle will be discussed. Within this portion of the township is located the southeastern part of the Elk City oil pool which is one of the oldest and largest yet discovered on the quadrangle.



MAP OF CLARION QUADRANGLE SHOWING OIL POOLS, GAS POOLS, LOCATIONS OF WELLS, STRUCTURE CONTOURS ON LOWER KITTANNING COAL (BLACK) AND ON TOP OF HUNDRED-FOOT SAND (RED).

Elk City Pool.—This pool was developed in 1875-76, the oil being found exclusively in what is thought to be the Third sand. The pool is now almost exhausted and a large per cent. of the wells have long since been abandoned. Facts regarding early developments in this pool are now difficult to secure in the field, as nearly all of the oil men who opened up the pool have scattered to other parts. It is known, however, that many of the wells had an initial production of from 100 to several hundred barrels per day. After over thirty years of constant production, a number of these wells are still making sufficient oil to justify pumping. In most of the wells of this pool the Third sand carries more or less salt water, which is found to decrease constantly in volume as the wells are pumped. When the salt water is exhausted in a well no more oil is produced. This is characteristic of many pools in the hundred-foot sand farther to the south in Allegheny, Butler and Washington counties, but in that area the appearance of water in the Third sand is usually a sign of early flooding and the production of salt water exclusively. The Third and Fourth sands are here separated by a very thin shale bed which in places is almost entirely wanting. The records of wells do not show the Fourth sand to be productive.

The Third sand has also furnished a number of excellent gas wells in this township. Among these are the Mires, Lutz and McLaughlin No. 2 well (Map No. 1), which came in September 7, 1904, with an estimated daily capacity of more than 150,000 cubic feet. The initial closed pressure of this well is not given. The C. J. and P. E. McCue No. 1 well and the E. D. Sheets No. 1 were also good gas wells in the Third sand, the latter having an initial capacity of more than 1½ million cubic feet per day.

In this township the Speechley sand has also been found to carry considerable gas in several wells, most of which are situated in the south and southeast of the Elk City oil pool. Of these, the Wilson, Vowinckel and Bryner, Nos. 2, 3, and 4, were probably above the average for this sand in Elk township. One or more wells on the above farm also made more or less gas from the Fifth sand. Taken as a whole, the gas pools of Elk township are small and of minor importance.

Structure.—On Plate IV it will be seen that the contour lines drawn on the Lower Kittanning coal show that the axis of the Clarion syncline crosses the northeastern corner of this township. With structures of this type no details can be shown by contours with a twenty-five-foot interval, and therefore, very little can be pointed out regarding the structure of the oil and gas pools. On Plate V are shown elevations on the 100-foot sand estimated from the Third sand, the interval being considered as 272 feet. From these elevations and the 25-foot contours drawn to show the probable structure of this sand it will be seen that the Elk City oil pool occupies the sides and crest of a flat, anticlinal fold which pitches very gently to the south.

During the course of the geologic work in this pool, spirit levels were run to a number of wells of which partial records have been obtained, as follows:

Farm Name.	Number.	Elevation.	Name of Sand.	Depth to sand—feet.
Shed well,	3	1,486	Third,	1,142
Yonkers, J.,	4	1,482	Third,	1,124
Black, Jacob,	3	1,399	Third,	1,042?
Bloch, B., Chamberlain well,	------	1,468	Third,	1,123
Sloan, P. M.,	1?	1,443	Third,	1,100
Boartly, B.,	7	1,373	Third,	1,028
Wilson, Vowinckel and Bryner,	?	1,158	Third, Fourth,	850? 1,759?

Map number.	Farm Name.	Number.	Elevation.	Name of Sand.	Depth to sand—feet.
------	Wilson, Vowinckel and Bryner,	1	1,180?	Third, Fifth, Speechley,	865 920 1,782
------	Wilson, Vowinckel and Bryner,	2	1,149	Speechley,	1,760?
------	Wilson, Vowinckel and Bryner,	6	1,314	Speechley,	2,040
------	Wilson, Vowinckel and Bryner,	3	1,146	Speechley,	1,765?
1	Mires, Lutz and McLaughlin,	2	1,341	Third, Speechley,	1,030 1,900

On Plate III three sections of wells, Nos. 1, 2 and 3, are plotted to scale and arranged as nearly as possible in correlation with sections of wells located farther to the south. The locations of all these wells are shown by corresponding numbers on Plate IV.

Well (Map) No. 2 is the Rohrer (Farm) No. 2, drilled in 1871 by C. E. Hatch of Edenburg, and is reproduced from a record given by Carll, but its exact location on the map is not indicated. This is also true for Well No. 3, Jacob Bloch No. 1, but sections of these wells are of special importance since they connect the plotted line of sections of this report with a similar one brought down from the northwest by Carll. (a).

(a) Second Geol. Survey of Pa., Vol. II.

The following records give a fair idea of the rocks encountered in this township.

Record of Hope No 1 Well (Second Geological Survey of Pennsylvania, Vol. II., p. 230).

Elevation above sea-level, 1,324.

	Thickness.	Depth.
Conductor, clay and sandy loan,	10	10
Sand,	54	64
Slate, gray,	7	71
Sand, brown,	8	79
Sand, white,	51	130
Slate, dark,	42	172
Sand, white,	27	199
Slate, black,	18	217
Sand, greenish,	8	225
Slate, gray,	5	230
Sand dark,	94	324
Slate, very dark,	70	394
Shale, gray,	25	419
Slate, gray,	90	509
Shale, dark,	30	539
Slate, whitish cast,	110	649
Shale, dark,	50	699
First sand, dark,	45	744
Sand, black,	10	754
Red rock,	10	764
Slate, black,	13	777
Sand, light,	22	799
Slate, reddish,	16	815
Sand, gray,	31	846
Slate, dark,	6	852
Red rock, dark red,	45	897
Slate, light,	12	909
Sand, greenish,	12	921
Slate, dark,	11	932
Sand, white,	3	935
Slate, light,	4	939
Third sand, dark,	3	942
Pebble and sand, some oil,	13	955
Sand,	22	977

Drilled dry; cased at 333 feet.
Best production, 5 barrels per day.

Record of Strotman No. 1 Well, Drilled in 1877, (Second Geological Survey, Vol. III, p. 415).

	Thickness.	Depth.
?	573	573
Shells, gas,	7	580
Slate,	167	747
Sand, pebble on top, gas "first sand,"	58	805
Slate,	37	842
Sand shells, gas,	38	880
Red rock,	10	890
Sand sheels,	10	900
Red rock,	14	914
Slate,	26	940
Sandy shells,	10	950
Slate,	34	984

Record of Strotman No. 1 well.—Continued.

			Thickness.	Depth.
Sand, dark, few pebbles,	9	Third sandstone,	20	1,004
Sand, dark and pebbly,,	5			
Sand, very dark and fine,	6			
Slate, gas,			15	1,019
Sand, coarse, pebble, gas,	3		12	1,031
Sand, fine,	9			
Slate,			17	1,048
Yellow pebble,			2	1,050
Slate,			6	1,056
Sand and yellow pebbles, gas,	2		8	1,064
Sand, white and hard,	6			
Slate and shells,			35	1,099
Red rock and shells, "chocolate," in layers,			16	1,115

Some little oil in top of third sand, but not in paying quantity.

BEAVER TOWNSHIP, CLARION COUNTY.

Only the eastern part of Beaver township, which lies south of Elk township, and north of Clarion river, is crossed by this quadrangle. Within this area no oil or gas fields of importance have been discovered, though at several places both of these have been found in limited quantities.

In the extreme northwest corner of this portion of Beaver township, a small part of the Elk City oil pool produces from a small area. South of this pool, gas has been found in the fourth sand at the George A. Hanst No. 1 Well (Map No. 4), which is located a short distance to the northeast of Madison schoolhouse. Gas in the Fourth sand was also found in two wells (No. 5) on the P. T. Kribbs farm a mile farther to the south. No. 1 on this farm lies west of the quadrangle and is not shown on the map. About three-quarters of a mile east of Well No. 5, two holes drilled in the valley of Deer Creek on the J. W. Reed farm (No. 6) are said to have been fair gas wells in the Fourth sand. In the eastern part of the township, two or three dry holes were drilled near the Beaver schoolhouse and on the river hill to the southeast of this point. About one-quarter of a mile west of this schoolhouse, on the John Olison farm (No. 7), the Oil City Fuel Supply Co. drilled a deep well to 138 feet below the Kane sand, which was here found to be 12 feet thick. The Third sand was 50 feet thick here, no mention being made of the Fourth and Fifth, though it is possible that the break between the Third and Fourth sands was not noticeable here and the 50 feet may represent both of them. Here the Speechley is 120 feet thick, but no Tiona sand is mentioned, the drillers calling special attention to the fact that no Bradford sand was found. (See Plate III, Well No. 7). This well was pronounced a dry hole by the Company, but sufficient gas is derived from the Speechley to partly supply the residence of Mr. Olison.

Between the years 1865 and 1870, a number of wells were drilled at the mouth of Deer Creek and along Clarion river (No. 8) for a short distance to the southwest. Old inhabitants, who remember some of the incidents relative to this development, say that the wells were thought to have been drilled to the Third sand and that they flowed a considerable quantity of oil, several hundred barrels of which were shipped down the river to Pittsburg in barges. This oil was accompanied by considerable gas which went to waste. Long after these wells were abandoned and plugged, the gas continued to bubble up through the water of the river in such quantities as to admit of its being burned over several square yards of the surface. Nothing now remains of this development. The total production of oil and gas from this portion of Beaver township has been of no importance.

Structure.—Plate IV shows the surface rocks of this township to be arched in a low anticline which pitches to the south. But little data is available regarding the structure of the oil-bearing beds. From what is known, the conturs on Plate V show the general shape of the Hundred-foot sand. The top of this sand is here estimated to be about 272 feet above the top of the Third sand. These contours show that the axis of the anticline which extends southward from the Elk City oil pool, passes off the western edge of the quadrangle a short distance north of Well No. 5. A low, broad anticlinal nose juts out from this fold to the southwest, crossing the Clarion river near the southeast corner of the township. Southward from this fold the rocks dip gently to the edge of the township.

So far as the writer could learn, less than twenty wells have been drilled in this area outside of the Elk City oil pool, and of these less than a dozen records have been secured, none of which are in sufficient detail to be of much value in noting changes in the lithological character of the rock section penetrated by the drill. Two of the three records given below are for convenience reprinted from the Second Geological Survey of Pennsylvania.

Record of John Olison No. 1 (?) Well (Map No. 7). Oil City Fuel Supply Company, Owners. Elevation 1356. Finished, November 26, 1904.

Well No. 702.

Top of third sand,	1050	feet—272=778=top 100 feet?
Bottom of third sand,	1100	“
Top of fourth sand,	1945	“
Bottom of fourth sand,	2065	“
No Bradford sand,		
Top of Kane sand,	2760	“
Bottom of Kane sand,	2772	“
Total depth,	2908	“

“Dry Hole.”

Record of Samuel Beal No. 1 (?) Well. Second Geological Survey of Pennsylvania, Vol. 11, p. 228. Elevation, 1,433.

	Thickness.	Depth.
?	90	90
Mountain sand,	209	299
?	602	901
First sand A,	25	926
Slate,	25	951
First sand B,	25	976
Shale, salt water,	42	1,018
Slate,	2	1,020
Second sand,	40	1,060
?	60	1,120
Red rock,	40	1,160
Boulder,	10	1,170
Slate,	11	1,181
Third sand, not through,	19	1,200

Drilled dry. Crevice at 208 feet.

Record of Widow Kribb No. 1 (?) Well. Second Geological Survey of Pennsylvania, Vol. 12, p. 228. Elevation, 1,404.

	Thickness.	Depth.
Coal,	2	27
?	48	75
Coal,	3	78
?	122	200
Sand (Mountain),	160	360
?	100	460
Sand (salt water sand),	40	500
?	353	853
Sand (first),	35	888
Slate,	25	913
Sand,	20	933
? including red rock,	117	1,050
Sand (Second),	15	1,065
Slate,	15	1,080
Red rock,	40	1,120
?	8	1,128
Sand boulder,	10	1,138
?	15	1,153
Sand (Third) not through,	21	1,174

Possible Location of Undeveloped Pools.—There seems to be small chance of securing large returns for prospecting in this part of Beaver township. Tests throughout the township show that all the sands are unusually hard and close, with thin and unreliable pay streaks. So far as known the structure is not unfavorable, especially for gas, along the western border of the quadrangle, and it is reasonable to expect pools of either oil or gas in several places, if the sands are good. Where neither the structure nor the condition of the sands are known definitely, suggestions relative to the location of test wells must be taken with a due amount of caution. Of such locations, probably the best for gas in the Third, Fourth and Speechley sands is on the hill one mile west of the Olison Well (No. 7). If Plate IV shows all the wells drilled to date in this vicinity, there is a possibility of finding oil and gas for a mile to the south and southeast of the Olison well.

PAINT TOWNSHIP, CLARION COUNTY.

That portion of Paint township situated within the Clarion quadrangle lies east of Elk and Beaver townships and north of the Clarion river. Within this area is located the Manor oil pool, a portion of the Miola oil and gas field and a considerable gas pool on Toby Creek, besides scattering gas wells in various parts of the township.

Manor Oil Pool.—This pool was discovered in 1892 or 1893 by a well on the S. E. Kizer farm, situated in the southwestern part of the township just east of where it corners with Elk and Beaver. Kizer No. 1 well (Map No. 9), started off at 10 or 12 barrels per day from what is supposed to be the Third sand. Number 2 on this farm had an initial production of about 60 barrels per day, and held up at that rate fo almost a year. This was the best well in the pool. Seven other producing wells were drilled on the Kizer farm, two on the farm of Joseph Hepinger and two on the property of G. B. Grace. The producing territory embraces about 100 acres and has been completely surrounded by dry holes. Of the wells named above only three or four are now pumping. Each of these produces only a barrel or less per day, the pool being almost depleted. These wells all pumped more or less salt water with the oil, both oil and water being exhausted simultaneously.

Half a mile or more northeast of the Manor oil pool, a well (No. 10) was drilled on the Clint Wilson farm in 1877 or 1878, in which a show of oil was found in what was considered the Third sand and a strong flow of gas in the Fourth. This gas is said to have been allowed to blow off on the air for years until the well was completely exhausted.

Less than a mile northwest of this well, one drilled on the Wm. Brinnaman farm got a light flow of gas at about 925 feet from what is probably either the Murrysville or the Hundred-foot sand. This well (No. 11) found the Speechley sand unproductive. A well on the John Grace farm a short distance southwest of Concord Church had a light flow of gas from the Third or Fourth sand with nothing in the Speechley. Another well on the T. Vowinckel farm to the southeast of Concord Church makes some gas from an upper sand, though the flow is very light. No records of the above wells could be secured, or of the Shannon No. 1 Well (No. 12), located to the southeast of Clarion Junction, though it was learned that this well had salt water in the Hundred-foot and gas in the Third and Speechley sands. The initial closed pressure in the Third sand is said to have been about 230 pounds, and that in the Speechley, 900 pounds per square inch Well No. 12 is one of a group of five or six wells drilled in this area, several of which are moderate gas producers.

A mile or more to the northeast of Well No. 12, a considerable gas pool has been developed on Rapp's Run and Toby Creek. Most of these wells have been producing for a number of years and it is said that a number of them are exhausted and abandoned. So far as could be learned, these wells all produce from the Speechley sand, which, in Well No. 13 on the Myers and Lutz track, is 160 feet thick. In this well the Third sand was reached at 1,030 and the Speechley at 1,930, giving an interval of exactly 900 from top to top of these sands.

Less than a mile north of these wells and off the quadrangle, two wells have been drilled on the Alexander Goble farm that have made good shows of oil in the Fourth sand, one of which is being pumped. A well (No. 6 on the Griswold tract) drilled about one mile a little north of east from the Goble wells, is said to have developed a closed gas pressure of more than 1,200 pounds from the Bradford sand.

Along the eastern border of the township from Clarion river northward a number of wells have been drilled within the last three years in an extension of the Miola oil and gas field. Since most of this field is located in Highland township, it will not be discussed as being in Paint township.

Structure.—Plate IV shows that the axis of the Clarion syncline crosses the southwestern portion of the township with a general southeast trend. On this plate no details of the folds in the surface rocks are shown. With these contours as guides, others were drawn on Plate V to show the best interpretation of the structure of the Hundred-foot that can be made from the few facts now available.

Stratigraphy.—No detailed records of wells within this township are available, and, therefore, but little is known of the condition of the principal oil sands over this area. Here the Big Injun or Mountain sand crops along the bluffs of Clarion river and is always found to carry more or less fresh water. The first sand is usually separated from the Big Injun below by much less than the average thickness (90 feet) of shale and red rock. In this sand, salt water frequently occurs. In many wells the Murrysville sand is apparently united with the Hundred-foot below. In all cases only a few feet of shale, or shales and sandstone (slate and shells), separate them. So far as could be learned in the field, both the Murrysville and the Hundred-foot sands are hard and close and seldom carry good paying streaks. Where these occur, it is said that they usually carry salt water. The Thirty-foot sand is generally reported thin and of no consequence. Below it the Third and Fourth sand group is everywhere present and of normal thickness. These sands are, at most, separated only by a few feet of shale, and in a number of places they are thought to be united in a single sand. Over Paint township, they are characterized as being hard and close with few patches of good pay. Salt water seems to occur in these sands only in areas that have considerable patches of pay, and especially where the sands are oil-bearing. The Fifth sand is thin and of no consequence as a producer of either oil or gas. The Keverline sand, which lies about 150 feet above the Speechley, has been found in a number of wells in Paint township. In this area the Speechley sand is of normal thickness, but usually carries a thinner pay than it does farther to the south. It is here the most prolific gas-bearing bed. No salt water is found in it, so far as could be learned. Little is known concerning the Tiona sand here, but it is thought to be thin or absent, and without production. The Bradford sands have not been touched by many wells in this township. Some of these, however, proved to be small gas producers. The closed pressure of gas in the Bradford sand group is said to reach a maximum of 1,200 pounds or more in this vicinity.

Prospective Oil and Gas Territory.—As over much of the Clarion quadrangle, the chance of finding good oil and gas territory in Paint township depends greatly on the quality of the sands in which the oil and gas are usually found. These sands appear to change both in thickness and quality quite rapidly from place to place, thereby making any predictions after a casual examination of the territory extremely hazardous. From the data, however, it seems safe to say that the best chance for a new oil pool is on Toby Creek at the northern edge of the quadrangle and for a mile due south of this point. If oil is found in this vicinity, it will probably come from the Fourth sand, and may be shown to have a more or less close connection with the Miola oil pool.

Other areas within this quadrangle seem to offer no special inducements for testing, though small pools are probably present.

HIGHLAND TOWNSHIP, CLARION COUNTY.

That portion of Highland township embraced by this survey has furnished large quantities of both oil and gas from the Third and Fourth sands.

Miola Oil and Gas Field.—This field is one of the youngest as well as the most prolific fields within the Clarion quadrangle. The field is about three miles long and one mile wide, and extends from near the southwest corner of the township northeast to a mile or more beyond

Miola, which lies just off the northern boundary of the quadrangle. Within this productive area the Third sand has been found to be gas-bearing in most of the wells drilled to that horizon. The majority of the unproductive wells in this sand are to the east and north, where it is said to have been found very hard and shelly with no soft pay. In all the wells the closed pressure has been comparatively light, ranging from less than 100 to about 250 pounds per square inch. The capacities of these wells are not known, but they are believed to be of only moderate size, probably very few having an initial capacity of more than one to two million cubic feet per day. Most of the gas wells have been drilled within the last ten or twelve years, but many of these are now practically exhausted.

Oil was discovered in the Miola field by a well on the Isaac Imhoff farm, in December, 1906. This well, which is located just off the quadrangle a short distance west of Miola, had been drilled to the Third sand about eight years previously, and during that time made gas from this sand. When the gas was exhausted, the well was drilled 10 feet deeper through two feet of shale into the Fourth sand, from which it began flowing oil at the rate of 80 barrels per day. During the oil excitement which followed, the gas wells in the Third sand surrounding the Imhoff well, and to the south and southwest were quickly converted into oil wells in the Fourth by deepening, and a large number of new wells were drilled to that horizon. Northward from the Imhoff well the Fourth sand was found to pinch out within 500 feet. In that part of the field, competing companies drilled no less than ten wells within an area of not more than eight acres. Of these wells, probably less than half were productive, and some of these will not prove profitable. In this area the writer was informed that the Fourth sand changes from a thickness of 72 feet to practically nothing within a horizontal distance of less than 300 feet. Southward from the Imhoff well the Fourth sand seems to remain fairly uniform in thickness and to furnish good wells over more than a square mile.

In the Miola oil and gas field the Third and Fourth sands carry but little salt water, though it is reported to occur in small quantities in most of the gas wells when they are nearing exhaustion.

Outside the Miola oil and gas field no oil and but little gas has been discovered in this part of Highland township. A small pool of gas has been opened up by Wells 14, 15 and 16 on the Benner, Walters and Crispin farms respectively This gas probably comes from the Murrysville sand which is locally known as the "salt sand." The sand is here about 10 feet thick, rather close and hard, and furnishes wells of only moderate size. The initial rock or closed pressure was about 180 pounds in 1896 when the wells were drilled. The Brenner Well has been pulled and the others are practically exhausted.

Structure.—Sufficient geologic work could have easily been done in the Miola oil and gas field to insure first-class results, if it had been possible to secure detailed records of wells. In most cases, these records were never made, and in others, such as were preserved could not be obtained. Because of the lack of this well-record information, the structure of the oil sands of this township cannot be shown. It is safe to say, however, that the contour lines of the surface structure, as shown on Plate IV, are not closely applicable to the oil sands of the Miola field, and but little reliance should be put in them in attempting extensions to the northeast. It is believed that to the northwest in Paint township the structure of the oil sands is more nearly depicted by the contours of the surface structure.

Stratigraphy.—So far as the records show, the stratigraphy of the unexposed rocks of this township does not materially differ from that given for Paint township. The most noteworthy difference is in the Fourth sand which appears to pinch out entirely for an unknown distance to the north and northeast of the Miola oil and gas field. In this area the Third and Fourth sands are separated by a few feet of shale. The total distance from the top of the Third to the top of the Fourth ranges from 45 to 65 feet. In many wells the "break" is entirely absent and the sands are united. It should be stated, however, that there is a possibility that the sands known in the Miola and Clarion fields as the Third and Fourth sands, are not exactly the same oil-bearing beds known by those names elsewhere, but it is positively known that they belong to either the Third or the Fourth sand group. It is therefore possible that the Third and stray or the Fourth and stray, are really the ones from which the oil and gas come.

The following record of the Albert Whisner well located off the quadrangle about half a mile northeast of Miola was given from memory by one of the drillers, and is therefore likely to be in considerable error. It is, however, the most complete record obtained of a well within this township.

Record of Albert Whisner No. 1 Well, Highland township. Clarion County. Drilled in July, 1907.

	Thickness.	From.	To.
Through mountain sand,			425
Break of shale,	3	425	428
Forty foot sand,	37	428	465
Break of shale,	4	465	469
Salt sand (Murrysville),	16	469	485
Break of shale,	3	485	488
Hundred-foot sand, slate and shells,	100?	488	588

Record of Albert Whisner No. 1 Well.—Continued.

	Thickness.	From.	To.
Break of shale,	4	588	592
Red sand,	10	592	602
Break of shale,	24	602	626
Second sand,	4	960	964
Big red rock,	60	964	1,024
Gas in bottom of sand.			
Bottom boulder,			1,148
Break,	12		
Third sand,		1,160	
Gas,		1,165	

There seems to be little chance of other oil pools similar to the Miola pool being found within this portion of Highland township, and with the data in hand no suggestions can be made regarding locations of test wells.

MILL CREEK TOWNSHIP, CLARION COUNTY.

A small portion of Mill Creek township is included in the northeast corner of the quadrangle, east of Clarion river and north of Mill Creek.

Within this area no oil or gas in paying quantities has been found, and but three records are available of wells drilled in the township. It is possible that only one of these is within the area shown on Plate IV. Fortunately, good records of these have been preserved, three of which have been published in the Second Geological Survey of Pennsylvania. Since the publication is now out of stock, these records are reprinted below:

Record of Abram James Well, Mill Creek township, Clarion county. Drilled, 1872-3-4.

	Thickness.	Depth.
Conductor,	25	25
Sand (sandstone) rotton; no limestone,	253	278
Mountain sand, white and gray (gas at 280),	157	435
Sand, gray (oil at 445 and 518),?	90	525
Slate, blue,	135	660
Sand, gray,	28	688
Slate,	30	718
Sand, gray,	12	730
Slate, with shells of gray sandstone,	120	850
Red rock (gas near bottom),	45	895
Slate, black, hard and gritty,	5	900
Sand, "boulder," gray and gritty,	30	930
Sand, "emery," fine and hard,	5	935
Slate, black,	11	946
Red rock,	5	951
Slate, blue, with shells,	62	1,013
Red rock,	7	1,020
Slate, black, with gray shells, first salt water, water,	92	1,112

Record of Abram James, well—Continued.

	Thickness.	Depth.
Shale, black and red; green sand near bottom,	13	1,125
Red sand,	4	1,129
Sand, gray (gas and oil show),	13	1,142
Sand, pebbly, dark gray,	11	1,153
Slate, with small "mustard seed" pebbles,	6	1,159
Sand, fine and light,	17	1,176
Slate, black with white shells of sand,	29	1,205
Slate, blue and soft,	18	1,223
Sand, light gray and fine,	33	1,256
Red sand, very red,	20	1,276
Soapstone,	167	1,443
Slate, dark and gritty (gas),	20	1,463
Slate, light,	5	1,468
Slate, blue with transparent pebbles,	10	1,478
Sand, gray and light gray,	21	1,499
Slate, dark,	17	1,516
Sand, light gray, hard,	27	1,543
Sand, white (gas and oil show),	2	1,545
Slate, light blue,	17	1,562
Sand, fine, dark gray (gas),	8	1,570
Shells of sandstone,	5	1,575
Sand, gray, coarser near bottom (gas),	30	1,605
Red rock, sand, fawn-colored, like paint, (gas and oil show),	23	1,628
Soapstone, light and soft,	13	1,641
Sand, gray and white, with shells and slate,	45	1,686
Slate, clear, white, no grit,	27	1,713
Red rock, hematite, very red,	6	1,719
Sand, "boulder," fine,	15	1,734
Soapstone,	14	1,748
Sand, nearly white (gas and oil),	22	1,770
Slate, blue, "buckwheat batter,"	60	1,830
Sand, white,	2	1,832
Slate, gritty,	6	1,838
Sand, sharp and white,	4	1,842
Slate white,	3	1,845
Sand (sandstone), (gas),	6	1,851
Slate, white,	28	1,879
Sand, hard,	2	1,881
Sand, coarser at bottom (gas and oil),	23	1,904
Shelly slate,	44	1,948
Slate, blue, free from grit,	49	1,997
Shelly slate,	43	2,040
Sand, fine (gas),	13	2,053
Shale, olive, free from grit,	10	2,063
Shale, olive, with brown shells (gas and oil),	49	2,112
Slate, light blue,	20	2,132
Soapstone, light brown,	20	2,152
Sand, white (large increase of gas),	3	2,155
Shelly slate,	7	2,162
Slate, blue and free from grit,	71	2,233
Sand, "boulder," very hard,	3	2,236
Shelly, very gassy slate,	25	2,261
Slate, light and soft, not gritty,	10	2,271
Sand, not through,	52	2,323

Cased at 314 feet, but salt water came in below the casing and stood all the time within 1,000 feet of the top, so that the well was virtually a "wet hole."

"We are now in a 'boulder' to the depth of 52 feet with reamer stuck. All through this rock so far we got much gas, and I am strongly of the opinion that a heavy oil producing rock lies immediately under this."

Partially tested at 1,200 feet, but not afterwards.

Unproductive.

The exact location of this well is not known. Probably both it and the one for the following record are located off the quadrangle to the north.

Record of Blyson Run Well, Mill Creek township, Clarion county.

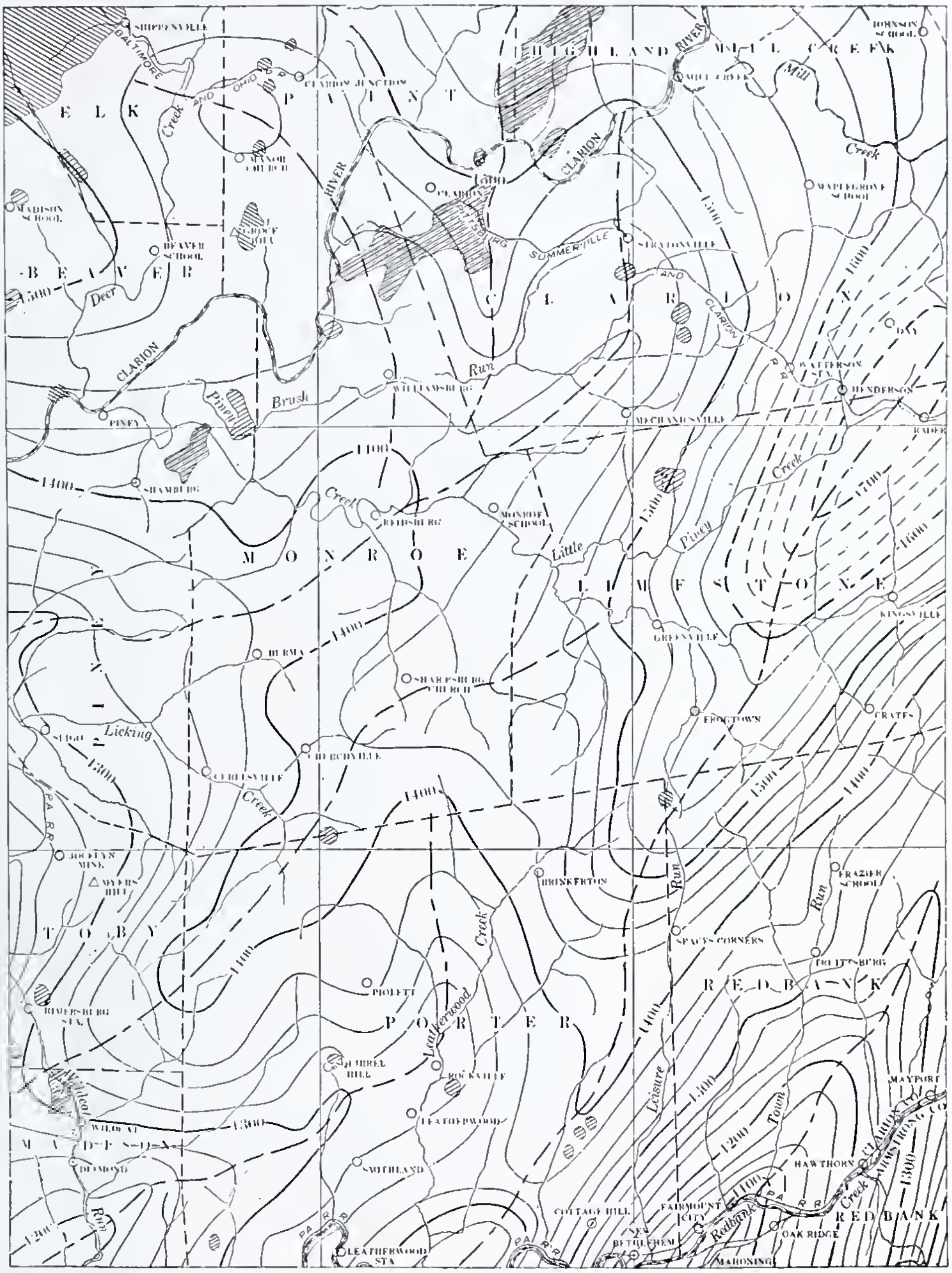
	Thickness.	Depth.
Surface rock,	21	21
Slate and sand,	29	50
Sand, white,	5	55
Slate,	20	75
Sand,	15	90
Slate,	20	110
Sand,	40	150
Slate,	126	276
Sand,	10	286
Slate,	10	296
Sand, white (oil and salt water at 314),	18	314
Slate,	21	335
Sand,	15	350
Slate (a little oil at 390 feet),	40	390
Slate and shells,	86	476
Sand (oil at 480 feet),	18	494
Slate,	6	500
Red rock,	20	520
Sand,	25	545
Red rock,	60	605
Sand,	25	630
Red rock,	110	740
Sand and shells,	20	760
Red rock and slate,	10	770
Sand, gas,	7	777
Red rock,	4	781
Red rock (2 feet pebble sand),	7	788
Slate and shell,	22	810
Sand, pebbles,	10	820
Slate and shells,	60	880
Red rock,	25	905
Slate and shells,	20	925
Slate,	120	1,045
Slate and shells,	310	1,355
Red rock, to bottom,	12	1,367

Located on Clarion River, near mouth of Blyson Run. Unproductive.

Without a better knowledge of the rocks cropping at the mouth of this well, it is not easy to correlate the sands mentioned in the record. It is very likely, however, that the sand with oil and salt water at 314 feet is the Salt or Murrysville sand with the Hundred-foot next below, and the Thirty-foot at 545, Snee or Blue Monday at 630, Boulder at 760, Third at 777, Fourth at 788 or 820.

Well No. 17—Record of George Wood No. 1 Well. Record furnished by Blyson Oil and Gas Co., Mill Creek township, Clarion county. Elevation 1,546.

	Thickness.	From.	To.
Conductor,			15
Slate,	35	15	50
Shells,	10	50	60
Coal,	5	60	65
Sand,	35	65	100
Slate,	25	100	125
Bluff sand,	75	125	200
White sand,	60	200	260



LOCATION OF KNOWN OIL AND GAS POOLS IN THE THIRD AND FOURTH SANDS IN THE CLARION QUADRANGLE

▨ Oil or gas in Third sand

▨ Oil or gas in Fourth sand

▨ Oil or gas in Third and Fourth sands

Contours are drawn on Lower Kittanning coal Datum plane is sea level.

Well No. 17—Continued.

	Thickness.	From.	To.
Coal and slate,	10	260	270
Mt. sand,	130	270	400
Cased in Red Rock at			400
Red rock,	15	400	415
Sand,	40	415	455
Red rock,	15	455	470
Sand,	30	470	500
Slate and shells,	100	500	600
Slate,	100	600	700
Slate and shells,	75	700	775
Shells,	25	775	800
Salt sand (Murrysville),	25	800	825
Slate,	75	825	900
First sand (= 100-foot),	25	900	925
Slate,	15	925	940
Red rock,	10	940	950
Sand,	50	950	1,000
Slate,	50	1,000	1,050
Red rock,	30	1,050	1,080
Slate,	20	1,080	1,100
Big red rock,	45	1,100	1,145
Slate,	5	1,145	1,150
Red rock,	26	1,150	1,176
Slate,	24	1,176	1,200
Third sand,	15	1,200	1,215
Shells and slate,	85	1,215	1,300
Total depth,			1,300

Little is known rgarding the possibility of oil pools existing in this area. From what could be learned in the field, oil men have avoided it because of the poor prospects of getting good pay sands both in the Third and Fourth and in the deeper sands.

CLARION TOWNSHIP, CLARION COUNTY.

Clarion township lies south of Paint, Highland and Mill Creek townships and extends from the eastern border of the quadrangle to a short distance west of the town of Clarion. Within this area more or less drilling has been going on since 1875. This has resulted in the development of the Clarion oil pools, and a considerable number of small gas pools in various parts of the township.

Clarion Oil Pools.—The first well drilled in this pool was finished in January, 1888, on the Normal School property in the eastern part of the borough. This well (No. 18) began flowing at the rate of 30 barrels per day. During the year 1888 more than twenty-five producing wells were drilled in this field. Of these, one of the largest was the Cadwallader No. 2, which at its best made as much as ninety barrels per hour. The maximum daily production of this pool was attained in 1888 when it is said to have produced approximately 3,000 barrels per day. The Third and Fourth sands, which are the oil-bearing horizons here, are separated at most by only a few feet of shale. Very little detailed information could be secured regarding the condition of these sands, but it is known that the pay streak is very erratic and subject to great changes in short distances. So far as could be learned, it seems that most, if not all, of the oil comes from the upper portion of these sands and possibly entirely from the Third. Salt water appears sooner or later in all the producing wells and contrary to what is its action in the Elk City Pool, it here drowns out the wells, many of which are now pumped incessantly in order to keep down the salt water. The pool will doubtless be eventually flooded by salt water, most of which appears to come from the Fourth sand. The general trend of this pool is northeast-southwest. At the time of the writer's visit, in July, 1907, a small amount of drilling was still going on in cautious extensions to the south.

On Brush Run, at the western edge of the township, a well (No. 19) on the David Fulton farm is said to have produced gas. Well No. 20 on the Corbett Mill tract half a mile farther to the east was unproductive. No record could be found for either of these wells, or for the W. H. Cooper No. 1 Well (No. 21) on Brush Run, three-quarters of a mile farther to the east. The elevation of Well 21 is about 1,325 feet, but it furnishes a copious flow of good, fresh water which is said to come from the mountain sand.

A mile farther to the east on Brush Run, a number of wells have been found with more or less gas in the Salt or Murrysville sand, and possibly in the Bradford sand. In this group, Wells 22 and 23 on the D. T. Kirkpatrick and the C. A. Rankin farms respectively, produce from the Murrysville sand at a depth of about 750 feet. The initial rock or closed pressure of the gas in Well 23, October 30, 1897, was about 250 pounds. On October 12, 1905, this was still as much as 67 pounds and varied 27 pounds from that of Well 22.

Well 24 on the Clark Potter farm was also a gas producer in the salt sand. It is now abandoned, but continues to flow a stream of salt water with the escape of little or no gas. In the W. C. Neil No. 3 well (25), the Fourth is said to be the gas-bearing sand. The initial closed pressure of no wells in this sand are available. Well 26 on the Johnson farm is said to have had a show of oil in the salt sand and gas in the Bradford. According to reports picked up in the field, this well carried the highest initial closed pressure of any well in Clarion county. Some statements are to the effect that this exceeded 1,000 pounds to the square inch. Others claim that it exceeded 1,500 pounds.

Barker No. 1 Well (27) found 15 feet of Fifth sand and gets its gas from the Fourth. No other records of wells in this group are available.

Two holes (Nos. 28 and 29) have been drilled to the northwest of Strattonville on the Hilson Heirs tract, but no data regarding these wells have been preserved except that No. 1 (28) was a light gas well.

Less than two miles northeast of Strattonville, a well (No. 30) was finished June 27, 1907, on the Wm. Knights farm, through the Bradford sand. Small shows of gas were found five feet in the Murrysville sand at a depth of 783 feet, and 12 feet in the Bradford at 2,317 feet. The well was abandoned. In the record of this well, no comment is made on the condition of the sands, but from what was learned of wells in this vicinity, the sands in the northeastern part of Clarion township are hard and close and carry few streaks of porous pay sands.

In the southeastern part of this township, Well 31, on the J. Frank Ross farm, got gas in the Bradford sand with an initial closed pressure of about 425 pounds. No data regarding other wells in this vicinity were secured.

Structure.—From Plate IV it will be seen that the axis of the Reidsburg syncline in the outcropping rocks crosses the southwest corner of Clarion township with a general northeast-southwest trend. In the vicinity of Well 23, the axis in this field swerves in a broad curve toward the north, crossing the northern border of the township at Clarion river near the southeast corner of Highland township. To the west of the Reidsburg syncline, the Miola anticline has an almost due northerly trend from the vicinity of Well 20. It passes a short distance to the east of the Clarion oil pool through the western edge of the Miola oil pool from which it takes its name. East of the Reidsburg syncline, the rocks rise rapidly to the crest of the Kellersburg anticline which crosses the southeast corner of the township.

So far as it has been possible to judge from the scattering elevations secured on the tops of the oil sands, the structure of these beds does not conform at all in detail with that shown for the surface rocks. As mentioned elsewhere, this variation in structure is principally due to a lack of parallelism in the strata above with those below the old land surface represented by the unconformity at the top of the Pocono formation (See Fig. 1).

In a very general way, the folds in the surface rocks and in those of the deeply buried beds parallel each other, but oil operators should constantly bear in mind in using Plate IV that great variations may naturally be expected to occur in very short distances between these two sets of structural features. In an area of this kind, a relatively accurate structural map of the oil sands can be made only by running spirit levels to every well in the area, and then by using steel line measurements to the top of an easily recognized oil sand. The exact elevation of this bed above or below a given datum can then be worked out, and contours drawn connecting points of equal height. Since a sufficient number of such points have not been secured over Clarion township, the structure of the oil sands will be only partially shown.

Among the wells to which spirit levels have been run are the following:

	Top of conductor above sea-level in feet.
John Campbell, No. 1,	1,526
Wm. Crooks, No. 1,	1,463
Wm. Lyntz, No. 1,	1,355
Potter Heirs, No. 1,	1,592
George Aron, No. 1,	1,489
Frank Ross, No. 1,	1,574
J. A. Cooper, No. 1, ?	1,455
W. C. Barber,	1,475
Mrs. Smathers, No. 1, ?	1,503
W. C. Neil, No. 3,	1,477
George Johnson,	1,457
Clark Potter,	1,364?
C. A. Rankin,	1,414?
W. H. Cooper,	1,325?

Stratigraphy.—The records secured of wells within this township are not in sufficient detail to admit of close comparisons of the stratigraphy of the unexposed rocks here with that of adjoining areas. Of these records, some are confidential and cannot be published. Of those remaining, the following are the best:

Record of Normal School No. 1 Well (Map No. 18), Reprinted from Second Geological Survey of Pennsylvania, Vol. I-5, p. 157. Elevation about 1,550. Drilled, January, 1888.

	Thickness.	Depth.
?	24	24
Slate,	16	40
Coal,	2	42
Slate,	40	82
Coal,	3	85
Slate,	57	142
Coal,	4	146
Slate and shells,	129	275
Sand, mountain sand (295 feet water),	120	395
"Conglomerate" (the specimen is sandy shale),	40	435
Sand, mountain sand (cased at 525 feet),	90	525
Slate,	40	565
Slate, red,	15	580
Sand,	70	650
Slate,	245	895
Sand, "first sand,"	30	925
Slate,	88	1,013
Red rock,	10	1,023
Slate,	120	1,143
Red rock,	25	1,168
Slate,	25	1,193
Red rock,	45	1,238
Slate,	15	1,253
Red rock,	15	1,268
Sand,	25	1,293
Slate,	4	1,297
Shells,	3	1,300
Sand, oil sand, not through,	11	1,311

Located on grounds belonging to the Normal School.
This was the first productive well drilled in the Clarion Pool.

From the record, the oil sand is easily comparable to the Fourth sand of the Miola oil field, the sand at 1,293 being equivalent to the Third. Considering the Hundred-foot to lie approximately 275 feet above the top of the Third, it is likely to be represented by a portion of the 88 feet of shell, the bottom of which is given at 1,013. In this instance, what is called the "First sand" from 895 to 925 might be the Murrysville.

A comparison of the two following records shows one of the difficulties of correlating sands from incomplete logs.

Record of Barber No. 1 Well (Map No. 27), Strattonville Oil and Gas Company. Elevation, 1,475.

	Thickness.	From.	To.
Mountain sand,		27	
Driven pipe,		27	
Casing,		511	
Salt sand,		733	
Second gas, salt water,		743	
Bottom salt sand,		789	
First sand,		919	931
Boulder,		1,150	
Fourth sand,		1,171	1,181
Fifth,		1,215	1,230
Total,			1,316

Record of W. C. Neil, No. 3 Well (Map No. 25), Home Gas Company. Elevation, 1,477.

	Thickness.	From.	To.
Casing,		525	
Mountain sand,		150	410
Green sand,		480	522
Forty-foot,		555	571
Salt sand,		816	828
Seventy-foot,		840	
Oil and salt water,		910	
Red valley,		1,020	1,031
Second sand,		1,055	1,072
Big red sand,		1,145	1,185
Boulder,		1,248	1,253
Fourth,	Gas ?	1,285	1,295
Fifth,		1,361	1,361

It will be noticed that there is a difference of two feet in the height of the well mouths, a difference of 123 feet in depth to top of Mountain sand, of 74 feet to top of salt sand, and 66 feet in thickness. There is also 78 feet of difference to top of Boulder sand and 114 feet to top of Fourth. These records have been carelessly kept.

Record of George Johnson Well (Map No. 26), Strattonville Oil and Gas Company. Elevation, 1,457.

	Thickness.	From.	To.
Conductor,		23	
Mountain sand,		140	415
Green sand,		475	552
Cased,		555	
Forty-foot,		560	656
Bastard sand,		775	790
Salt sand,		810	847
Show of oil,		817	
Speechley,			2,180
Gas,		2,168	
Bradford,		2,240	2,280
Frogtown sand,		2,333	2,360
Kane sand,		2,419	2,436
Total,			2,800

Record of Wm. Knights No. 1 Well (Map No. 30), People's Natural Gas Company. Elevation, 1,530 (?).

	Thickness.	From.	To.
Injun sand,		145	568
Murrysville sand (little show of gas 783),		778	800
Hundred-foot sand,		835	945
Thirty-foot sand,		962	987
Speechley sand,		2,018	2,047
Bradford sand (show of gas 2,317+57),		2,305	2,330
Total depth,			2,462

Dry hole.

Completed June 27, 1907. Little show of gas in Murrysville sand at 783 feet and in Bradford at 2,317 feet, but the well was practically dry and was abandoned.

Probable Location of Productive Territory.—Without the guidance of a good structural map of the oil sands of this township, and a more detailed knowledge of what was found in the wells that have already been drilled, it may be suggested that the southern portion of the Clarion oil pool might be considerably extended in a northwest-southeast direction along the trend of the structural contours on Plates IV and V. No other parts of the township seem to offer special inducements for tests for oil, though this area probably carries a number of small gas pools that might be profitably exploited. The positions of these pools are evidently more dependent upon the condition of the sands in which they occur than upon their structural position as determined by contours on the surface rocks. In the present state of geologic knowledge relative to oil and gas in this township, prospecting is little more than a gamble.

MONROE TOWNSHIP, CLARION COUNTY.

Monroe township occupies a large area in the central part of the quadrangle to the southwest of Clarion township, from Clarion beyond the village of Curllsville.

Within this township a large number of wildcat wells have been drilled resulting in the discovery and development of the southern portion of the Clarion oil pool in the northern part, the Kifer oil pool in the south central part, one or two small oil wells north of Reidsburg, the Bittenbender gas field along the southern border, and a number of small gas pools throughout the township. The total production of oil outside of the Clarion pool has been very small, but some of the best gas wells in the quadrangle are in this area.

Clarion Oil Pool.—Only the southwest end of this pool lies in Monroe township. It is the youngest portion of the developed area and a small amount of drilling is still being done in this vicinity. All of the oil in this pool is said to come from the Third and Fourth sands.

Southwest of the Clarion Pool Well 32 on the Reid (?) Heirs farm was drilled through the Tiona sand at a depth of about 2,200 feet. In it a show of oil was found in the Fourth sand. The record of this well is given below:

Record of Well 32, B. F. Reid, No. 1. Record furnished by T. W. Phillips Gas and Oil Co. Elevation, 1,335.

	Thickness.	From.	To.
Forty-foot,	50	16	66
Mountain,	195	80	275
First,	170	300	470
Gas sand,	(?) 400	670	----------
Hundred-foot,	92	820	912
Thirty-foot,	55	955	1,010
Blue Monday,	10	1,015	1,025
Third,	40	1,085	1,125
Fourth (some oil from 1,145 to 1,150),	40	1,130	1,170
Fifth,	50	1,190	1,240
Speechley,	132	2,000	2,132
Stray,	25	2,165	2,190

No data are available regarding gas well No. 33. On the C. Longwell farm, Well 34 is said to have been a small gas producer. Well No. 35, on the T. A. Klingensmith farm has an elevation of 1,405 feet above sea level. Half a mile farther to the south the J. M. Neely No. 1 well (36) found gas in the Thirty-foot, Speechley and Bradford sands. The elevation of this well is 1,192 feet. A partial record of it is given under Stratigraphy, page .

Well No. 37, at Reidsburg, which is known as the Hinman well, is said to get its gas from the First sand at a depth of about 600 feet.

It is probable that this sand is the same as that called the "gas sand" in the record of Well 36, in which case the top of the Hundred-foot sand should be about 170 feet below. This well has an elevation of 1,175 feet. Its initial gas pressure was about 275 pounds in one and a half minutes in a two inch pipe. The well was drilled in 1891 and is said to continue to furnish a large portion of the gas consumed by the village of Reidsburg.

In well 38 on the Wm. Irvin farm, gas was found at a depth of 760 feet in what probably corresponds to the same gas-bearing sand of Well No. 37 at Reidsburg. This well at 963 feet produced 13 barrels of oil per day from what is mentioned in the record as the Third sand, but which, in the writer's opinion, may be either the Murrysville or Hundred-foot. The Third sand is normally from 260 to 275 feet below the top of the Hundred-foot, and since it is said that this well was drilled later to 1,201 feet and stopped in red rock, there is a reasonable chance that the horizon of the Third sand in this well has not been reached. All indications show that this well is located almost in the bottom of the Reidsburg syncline, and the oil sands therefore lie deeper beneath the surface than they do farther to the east and north. This well pumped oil for five years, and gas from it is still used in two residences. It has an elevation of 1,353 feet above sea level.

Wells 39 and 40 were small gassers in the upper sand.

A mile east of the Wm. Irvin well, one drilled on the D. Conner farm (No. 41) got gas at 715 feet in what was called the Salt or Murrysville sand. The following is a record of this well as furnished the writer by Mr. H. M. Fenstamaker of Clarion, who gave it from memory:

Well No. 41, D. Connor No. 1. Elevation, 1,320 feet.

	Thickness.	From.	To.
Bottom of Big Injun or Mountain sand,			350
Shale, about,	80		
Forty-foot sand, about,	100		
Salt sand, nice pebbly sand, about,	15	715	730
Gas, closed pressure 245 pounds,		715	730
Break (shale), about,	25		
Sand (heavy dose of salt water), about,	40		
Break (shale),			
Second sand,	50	800	850
Red pay, about,	30		
Break (shale),			
Red sand, hard,	25		
Break (shale),	15 or 20		
Big red rock,	40		
Break (shale),	12		
Red rock,	10		
Third sand (no water),	30	1,100	1,130
No fourth sand.			

From the record it is difficult to determine the top of the Hundred-foot sand. Assuming that it is the sand at 800 feet, which appears to be most likely, what is given as the Third sand is really about the horizon of the Fourth. This would give a dip in the Hundred-foot sand of 127 feet from Well 41 to Well 40.

About one mile southeast of Reidsburg, a well drilled on the T. W. Frampton farm (No. 42) is said to have filled up with oil, but after producing about 250 barrels began pumping salt water exclusively.

Kifer Oil Pool.—Less than a mile southwest of Well 42, a well (No. 43) had previously been drilled on the Andrew J. Kifer farm which is said to have made about 15 barrels per day for a year or more before it was drowned by an incursion of salt water. Eight other wells were drilled in close proximity to this one without finding oil. The oil from this pool was refined at the well and sold from wagons throughout the surrounding country. No. 43 had an elevation of approximately 1,322 feet. No records of any of the wells in this group could be found.

Well 44, David Kline No. 1, which has an elevation of about 1,315, got the gas sand at 780, the Hundred-foot at 900, Third at 1,200, Speechley at from 2,120 to 2,155 feet from the top. This well is believed to get its gas from the Speechley.

The records of Wells 45 and 46, as given below, give a fair idea of the thickness of the sands and the intervals between them in this vicinity.

Record of Well No. 45, Lafayette Shirley No. 1. Record furnished by W. T. Phillips Gas and Oil Co. Elevation of top of casing, 1,298 feet.

	Thickness.	From.	To.
Hundred-foot sand,	50	845	895
Third sand,	40	1,155	1,195
Fourth sand,	25	1,210	1,235
Speechley,*	53	2,055	2,108
Bradford,†	35	2,480	2,515

*Gas at 2,075 and 2,090.
†Salt water in Bradford sand. About 5 barrels per day.

Record of Well No. 46, Charles McElrary No. 1. Record furnished by the Apollo Gas Co. Elevation about 1,320 feet. Completed September, 1902.

	Top.	Bottom.
Mountain sand,	120	345
Murraysville sand,	760	770
Hundred-foot sand,	860	900
Thirty-foot sand,	910	948
Speechley sand (gas),	2,110	2,142
Tiona sand,	2,200	2,242
Second sand, Bradford,	2,431	2,520
Brown sand at 2,483 feet,		
Show of oil and salt water at 2,500 feet,		
Green sand 20 feet from bottom,		
Brown sand with show of oil,	2,690	2,710

Dry well.

In both of these wells, it will be noticed, mention is made of salt water in the Bradford sand. This sand is generally found to be without a perceptible amount of water where it has been touched by the drill in Clarion quadrangle. The same may also be said of the Speechley and Tioua sands.

Of Well 47 on the H. Harriger farm, the following record was secured:

Record of Well 47, H. Harriger No. 1. Record furnished by T. W. Phillips Gas and Oil Co. Elevation, 1,329.

	Thickness.	From.	To.
One hundred-foot sand,		790	
Speechley sand,	25	2,120	
Sheffield sand (first Bradford),	5	2,435	
Bradford sand (second),	20	2,485	
Depth drilled,			2,560

In this record it will be seen that the distance from the top of the Hundred-foot to the top of the Speechley is given as 1,330 feet. In wells Nos. 45, 46, 48 and 51, this distance is given as 1,210, 1,250, 1,195 and 1,195 respectively. From this, it seems very probable that the Hundred-foot sand, as given in Well 47, is in reality the Murrysville, the top of the Hundred-foot being at about 900 feet. A section of this well is shown on Plate III.

Record of Well 38, Bashline No. 1. Record furnished by E. W. Yockey.

	Thickness.	From.	To.
Bottom mountain sand,		500	
Slate and shells (?),	310	500	810
Murraysville sand,	15	810	825
Slate and shells,	105	825	930
Hundred-foot sand,	20	930	950
Slate and shells and red rock,	200	950	1,150
Boulder sand,	40	1,150	1,190
Slate, shells and red rock,	20	1,190	1,210
Third sand (probably fourth also),	75	1,210	1,285
Slate and shells (black),	65	1,285	1,350
Fifth sand,	50	1,350	1,400
Slate and shells,	725	1,400	2,125
Speechley sand (gas at 2,142),	30	2,125	2,155
Slate and shells,	297	2,155	2,452
First Bradford sand (gas at 2,452),	7	2,452	2,459
Slate and shells,	31	2,459	2,490
Second Bradford sand,	20	2,490	2,510
Slate and shell to bottom at,			2,560

The 20 feet of Hundred-foot sand probably represent only the lower member of this bed. The top of this sand is probably represented by the slate and shells 30 or more feet above. In this well fresh water was encountered as usual in the Mountain sand. Below this no other water was found! This well is plotted on Plate III.

The Speechley sand carries gas in the D. A. Kettner No. 1 Well (No. 49). This sand is here 100 feet thick with the pay streak 74 feet from the top.

No record of the Amos Snyder No. 1 Well (No. 50) is at hand. The mouth of this well is at an elevation of 1,370 feet above sea level.

In the Joseph Hamm No. 1 Well (No. 51), gas was found in both the Speechley and Tiona sands, the largest production coming from the former.

In No. 2 on this farm (No. 52), gas with a little salt water was encountered in the Hundred-foot sand. The Second Bradford sand in this well was foundto be 30 feet thick at 2,590 to 2,620 feet deep.

Well 53 on the Margaret A. Braughler farm got gas in the Hundred-foot and Speechley sands. This well has an elevation of about 1,390 feet.

The following record may be contrasted with those preceding to show the uncertainty of all drillers having the same names for identical sands. In it the Hundred-foot sand is given as being 1,364 feet above the Speechley, which according to the above records is probably 150 feet too much. This difference may be partly due to the natural variations in the intervals between the beds from place to place, but it cannot account for the sudden changes that are shown by a comparison of the well records of different drillers. Other differences are as apparent.

Record of Well No. 54, Lee No. 1. Apollo Gas Company.

	Thickness.	From.	To.
Mountain sand,		290	570
Murrysville (gas),		910	930
Hundred-foot (little gas),		945	1,005
Third sand,		1,360	1,375
Fourth sand,		1,410	1,440
Speechley sand (gas),		2,309	2,353

Abandoned December 26, 1901.

Bittenbender Gas Pool.—This pool extends into Monroe township from the south, only three or four wells of the pool being within this area. Of these wells No. 55, on the H. H. Henry Heirs property got gas in the Murrysville and Hundred-foot sands, and No. 56 found more or less gas in the Murrysville, Thirty-foot (?), Speechley and Bradford sands. Because of the unusual completeness of these records and of their stratigraphic value, they are both printed in full below.

Record of Well 55, H. H. Henry Heirs. Record furnished by the Apollo Gas Co. W. A. Louden, contractor. Elevation, 1,380.

	Thickness.	From.	To.
Clay,	27	0	27
Limestone,	8	27	35
Slate,	15	35	50
Sand,	162	50	212
Slate,	25	212	237
Mountain sand,	238	237	475
Slate,	10	475	485
Sand,	74	485	559
Slate,	7	559	566
Sand,	82	566	648
Slate,	10	648	658
Sand,	33	658	691
Slate,	91	691	782
Murraysville sand (gas),	15	782	797
Slate,	15	797	812
Hundred-foot sand (gas in top),	65	812	877
More gas 30 feet in sand.			
Salt water at 45 feet in sand.			
Full of salt water in bottom of sand.			

Record of Well 56, C. L. Phillips. Record furnished by Apollo Gas Co. W. A. Louden, contractor. Elevation, 1,410.

	Thickness.	From.	To.
Clay,	20	0	20
Limestone,	5	20	25
Slate,	45	25	70
Sand,	50	70	120
Slate,	30	120	150
Sand,	20	150	170
Slate,	10	170	180
Sand,	60	180	240

Record of Well No. 56—Continued.

	Thickness.	From.	To.
Slate,	20	240	260
Mountain sand,	200	260	460
Slate,	5	460	465
Sand,	40	465	505
Slate,	11	505	516
Red rock,	5	516	521
Sand,	20	521	541
Slate,	15	541	556
Sand,	125	556	681
Slate,	121	681	802
Hard shell,	5	802	807
Slate,	3	807	810
Murraysville sand,	17	810	827
Slate,	3	827	830
Slate,	15	830	845
Hundred-foot sand,	85	845	930
Slate and shells,	84	930	1,014
Sand (gas),	10	1,014	1,024
Slate and shell,	106	1,024	1,130
Red rock,	35	1,130	1,165
Slate,	24	1,165	1,189
Red rock,	41	1,189	1,230
Slate and shell,	15	1,230	1,245
Red rock,	18	1,245	1,263
Slate,	18	1,263	1,281
Third sand,	23	1,281	1,304
Red rock,	18	1,304	1,322
Fourth sand (gas),	25	1,322	1,347
Slate,	49	1,347	1,396
Red rock,	29	1,396	1,425
Slate and shells,	769	1,425	2,194
Speechley sand (gas 4 feet),	38	2,194	2,232
Slate,	100	2,232	2,332
Tiona sand,	20	2,332	2,352
Slate and shell,	188	2,352	2,540
Bradford sand (gas 20 feet in sand),	30	2,540	2,570
Break in sand. Slate,	12	2,570	2,582
Bradford sand,	30	2,582	2,612
Slate,	48	2,612	2,660

Well 57, on the James Stewart farm, has an elevation of 1,320. No record of this well is at hand.

Neither record nor elevation of Well 58, on the Jack Hartman farm, was secured. Northward from this well it is said that no wells have been drilled nearer than No. 59 on Craggs Run. This well was drilled through the Speechley sand, but found little or no gas.

No. 60 on the Jennie Fulton farm by T. W. Phillips Gas and Oil Co. is a small gasser in the Speechley. Number 61 on this farm was drilled by another company and is said to have been a good gas well. It is reported that this well blew open for a long time, most of its gas going to waste. No. 62 is the P. M. Leech No. 1 and is said to have been a dry hole.

A mile northeast of No. 62, a well (No. 63), was drilled on the A. B. Larch property by the Emlenton Gas Co. This well is said to get its gas from the Fourth sand and had an initial five-minute pressure of 300 pounds.

Structure.—The dominant structural feature of Monroe township is the Reidsburg syncline which passes through the middle in a general northeast-southwest trend. In the vicinity of Reidsburg, the Clarion syncline, a minor trough, extends northward from the Reidsburg syncline, its axis crossing the northern boundary of the township on Clarion river west of the town of Clarion. The Rimersburg anticline crosses the southeast corner of the township.

Details of the structure of the oil sands over this quadrangle have not been worked out. By a comparison of the Black and the Green contours on Plate V., it will be seen that the structure of the surface and the underground beds differs both in the position of the folds and also in the intensity of the folding.

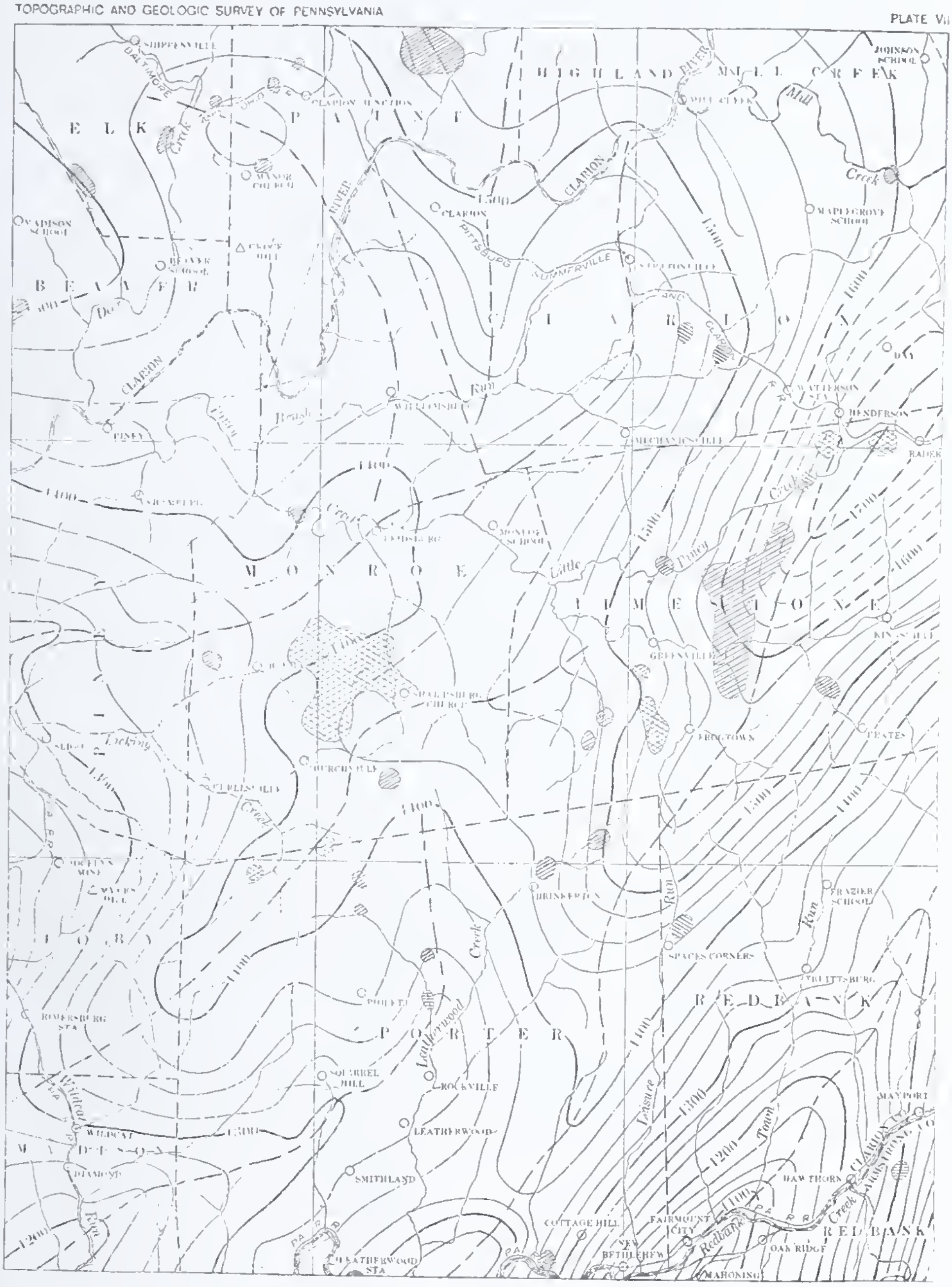
A sufficient number of spirit level elevations have been secured on the Hundred-foot sand in this area to permit of a fairly accurate outline being made of the more prominent structural features of the oil sand.

Probable Locations of Productive Territory.—From a study of the contours on Plate V., and of the locations of wells described above, it seems probable that a number of small gas pools may be found along the crest and northwest flank of the Rimersburg anticline in this township wherever the sands afford good open pay streaks. Probably one of the surest locations for gas in the Speechley or Hundred-foot would be to the south-southeast or east of well 53. There is also no structural reason why a well located one quarter to half a mile east of No. 42 should not get gas in the Speechley and Bradford, and at the same time stand a chance of getting some oil, both in these sands and in the shallow sands. Also, if oil is to be found in the Third and Fourth sands in this quadrangle east of the Reidsburg syncline, probably the best structural place for it is on the border of this township east of Well 42.

PINEY TOWNSHIP, CLARION COUNTY.

The eastern portion of Piney township lying west of Monroe township and south of Clarion river, is included within the quadrangle. In the central and northeastern parts of this area, there have been developed some fair-sized gas pools of moderate capacity, and in one or two places more or less oil has been found.

The northern part of this township was the scene of very early oil operations, the first well having been drilled as early as 1865. Of these, a record of the Madison Well No. 2 is given below. The exact location of this well is not positively known. A somewhat abbreviated record of this well was published in the Second Geological Survey of Pennsylvania, Vol. II., p. 236.



LOCATION OF KNOWN OIL AND GAS POOLS IN THE BRADFORD TIONA AND SPEECHLEY SANDS IN THE CLARION QUADRANGLE

▨	▨	▨	▤	▨
Speechley sand	Bradford sand	Speechley and Bradford sands	Tiona sand	Speechley Bradford and Tiona sands

Contours are drawn on Lower Kittanning coal Datum plane is sea level.

Record of Well 64, Madison No. 2. Piney Creek, Piney township. Drilled in 1865.

	Thickness.	From.	To.
Surface,	13		13
Red sand,	10	13	23
White sand,	72	23	95
Blue sand,	85	95	180
Slate, red and blue,	58	180	238
Blue sand,	15	238	253
Hard gray sand (fresh water),	23	253	276
Blue sand,	98′ 3″	276	374′ 3″
Slate, hard,	70′ 6″	374′ 3″	444′ 9″
Slate and shale,	65′ 3″	444′ 9′	510
Soft slate,	10	510	520
Gray, hard sand or pebbles, oil and gas (crevice) and salt water,	20	520	540
Blue slate,	112	540	652
Blue sand, hard,	32	652	684
Gray sand,	15	684	699
Blue slate,	71	699	770
Blue sand, crevice, gas,	5	770	775
Slate and shale,	68	775	843
Sand, very hard,	174	843	1,017
Third sand (?), small pebbles,	32	1,017	1,049
Total,			1,049

Wet hole, good oil shows while drilling, but unproductive.

Of other wells drilled later along Piney Creek and between this stream and Clarion river to the north, but little was learned. It is said that Well 64 on the George Banner farm was a fine gas well which was allowed to blow wild for some time before the gas was utilized.

A number of other wells in this group are still furnishing a considerable quantity of gas to the pipe lines. It is said that good shows of oil were encountered in some of these wells, but nothing authoritative can be said regarding the depths at which this oil occurs.

Shamburg Oil and Gas Pool.—The record of Well 65, which is No. 1 on the D. T. Bartlett farm, shows gas both in the Hundred-foot and Third sands, but since only the distances to the tops of these two sands are given, the writer has no means of verifying this statement. Well 66 of the John Finnefrock No. 2 is still pumping one or two barrels of oil per day. No record of this well is at hand. The record of 67, Henniger and Weber No. 1, mentions gas in the Hundred-foot and oil in the Third sands. This well has an elevation of 1,378 feet. In the D. B. Finnefrock No. 2 well (68) the oil was found in what is called the Fourth sand, which is here reported to be 80 feet thick with a 38-foot pay streak 7 feet from the top of the sand. In this well the top of the Hundred-foot is given at 913, and that of the Fourth at 1,183. This is the generally correct interval between the tops of the Hundred-foot and Third sands throughout most of the quadrangle. The Third and Fourth sands, may be united in this well. The elevation of Well 68 is 1,401 feet.

The following record is one of the most complete obtained of wells in this pool:

Record of Well No. 69, John Wassun No. 2. Record furnished by T. W. Phillips Gas & Oil Co.

	Thickness.	From.	To.
Forty-foot,	50	75	125
Mountain,	210	145	355
First,	160	370	530
Hundred-foot,	75	720	795
Thirty-foot,	30	850	880
Boulder,	20	945	965
Third (oil and gas, 980-985),	47	980	1,027

This well is said to have shown up as an oil well, but after being shot with 80 quarts of nitroglycerine, it pumped salt water exclusively. More or less salt water is thought to have been found in the Third and Fourth sands in the wells of this pool.

West of the Shamburg oil and gas pool the only well (No. 70) located within the quadrangle is on the Martin Carney farm. This is said to have been a small gas producer.

On Anderson Run, Well 71, the S. M. Meyers No. 1, was drilled through the Fifth sand. In it gas was found in the Hundred-foot, 64 feet from the top of the sand, which is here given as 90 feet thick. The Third, Fourth and Fifth sands are given as 20, 12 and 15 feet thick respectively, and at depths of 1,110, 1,150 and 1,180 feet. The mouth of this well has an altitude of about 1,270 feet above sea level. About half a mile south of this well, No. 73 on the F. C. McEwen farm, got a show of gas in the gas sand, and a considerable flow from the Thirty-foot. The following record of this well is given:

Record of Well 73, F. C. McEwen No. 1. Record furnished by Mr. F. C. McEwen. Elevation, approximately 1,295 feet.

	Thickness.	From.	To.
Conductor,			15
Top seventy-foot sand,			110
Bottom seventy-foot sand,			180
Mountain sand,	100	200	300
First sand,	60	320	380
Gas sand,	50	650	Gas (?) 700
Murraysville sand,	30	770	800
Hundred-foot sand,	20	930	950
Thirty-foot sand,	22	974	996
Gas main flow,			992
Total,			996

Gas well No. 72 is also located on the F. C. McEwen farm, but no record of it is at hand. It has an approximate elevation of 1,346 feet.

Well 74 is a dry hole on the A. H. Smith farm, in which the Hundred-foot sand was found at a depth of 965 feet. A very poor Fourth sand is recorded at 1,235 feet. The well mouth has an elevation of 1,371 feet. Well No. 75, the George Gomley, has an elevation of 1,196 feet. No data regarding other wells of this group were secured.

The record of Ellen Berrean No. 1 Well (76) gives only the top of the Hundred-foot sand at 919, with gas at 928. This well has an elevation of 1,307 feet. In No. 77, known as the J. B. Miller Well No. 1, by T. W. Phillips Gas & Oil Co., 12 feet of gas (?) sand was found at 802 feet; below this were 33 feet of slate and shell. At a depth of 950 feet the drill penetrated 10 feet into a sand said to be the Hundred-foot, in which a good flow of gas was found. The elevation of the well is 1,268 feet which would give a dip of 56 feet between wells 76 and 77, which seems to be unusually great. The mouth of the Charles Craig No. 2 Well (No. 78) is given as 1,268. This well got gas in what is called "gas sand" at 990 feet, and top of Fourth sand at 1,300. No other information is given by the record. This gives a dip of 45 feet between Nos. 77 and 78. This is an unusually steep dip for the rocks of this region and the writer is inclined to believe that a mistake has been made, either in using the wrong record, or in the elevation of the well, or possibly in the identification of the Hundred-foot sand.

Record of Well 79, J. B. Miller No. 1. Record furnished by J. B. Miller. Elevation, 1,145.

	Thickness.	From.	To.
Conductor,			9
Slate,	21	9	30
Soft blue sandstone,	34	30	64
Mountain sand, hard, two breaks, 2 ft. each, one one-half way, other well down,	198	64	262
Blue, sandy, shaley slate,	123	262	385
Blue sandstone, salt water,	31	385	416
Slate and shale,	25	416	441
Blue hard sandstone,	49	441	490
White sandstone and hard slate,	5	490	495
Slate and shale,	215		
Black sandstone, gas, little,	10	710	720
Slate and shale,	65	730	780
Red rock,	5	780	785
First sand, gas pay (1 bbls. of oil a day, yield from 785); salt water (5 feet of white conglomerate sand at the top),	18	785	808
Slate, blue,	20	808	828
Red rock,	5	828	833
Hard sandstone, gas, 15 ft. in sand,	60	833	893
Black slate,	40	893	933

Record of Well 79, J. B. Miller No. 1—Continued.

Red rock, pebbly top, close bottom,	12	933	945
Slate and shale,	10	945	955
Second sand, hard and shaley,	18	955	973
Red rock (above big red shell),	17	973	990
Sandy slate and shale,	66	990	1,056
Third sand,	2	1,056	1,058
Blue slate,	6	1,058	1,064
Blue sandstone and red rock,	11	1,064	1,075

Good gas well.

In the above record the writer is by no means certain of the identity of the Hundred-foot sand, but on both structural and stratigraphic grounds, he is inclined to think this is the one given at 846 as gas-bearing. It is possible that a study of material on the Foxburg quadrangle to the west may show that the sand at 790 feet is really the Hundred-foot, in which case the structural contours on Plate V. will not be found to join those to be drawn later on the Foxburg quadrangle.

The following records of old wells not located on the map are reprinted for their stratigraphic value:

Record of Sligo Well. Second Geological Survey of Pennsylvania, Vol. II., p. 234. Drilled in 1865.

	Thickness.	Depth.
Conductor,	15	15
Slate (soft and light, 22 ft.; black, 5 ft.),	27	42
Sand, hard,	7	49
Slate soft and black,	6	55
Sand, hard,	7	62
Slate, shelly,	3	65
Coal,	2	67
Sand (water at 128 ft.),	116	183
Slate, top hard, bottom soft,	85	268
Red rock, soft slate,	2	270
Sand, soft,	10	280
Slate,	90	370
Sand, close-grained and blue,	20	390
Slate,	49	439
Sand, hard and blue,	27	466
Slate, soft, "resembling fire-clay,	284	750
Red rock, soft slate,	5	755
Sand, hard,	10	765
Slate, blue,	21	786
Red rock (slate),	29	815
Slate, blue,	77	892
Red rock (slate),	3	895
Slate, brown,	30	925
Slate, hard and soft alternating (oil),	112	1,037

Record of Sligo Well—Continued.

	Thickness.	Depth.
Slate, blue and shelly,	14	1,051
Sand, blue,	30	1,081
Sand, blue and red,	36	1,117
Sand, white and hard,	11	1,128
Sand, red and white,	13	1,141
Sand, blue and red,	10	1,151

No paying production.
Salt water at 128 ft., 380 ft., and 450 ft.
Well mouth 173 ft. below the ore bed.

Elevation of top of conductor pipe above tide water, at Philadelphia, 1,130 ft. The Sligo Branch R. R. base makes it 1,088 ft.

(How these varying elevations were obtained, we do not know. Our adjustment of R. R. levels raises the Low Grade or Bennett's Branch Railway 26 ft., and no doubt carries up the Sligo Branch also; then 1,088+26=1,114, as the level of the well mouth above ocean, as against 1,130+7=1,137, by the Philadelphia tide water datum.) Licking Creek, Piney township.

Record of Sligo Furnace Well, on Licking Creek. Proceedings of Am. Phil. Soc., Vol. X., p. 63.

	Thickness.	Depth.
175 ft. below Buhrstone ore bed:		
Conductor,	15	15
Slate light,	22	37
Slate, black,	5	42
Sand, hard,	7	49
Slate, black,	6	55
Sand, hard,	7	62
Sand and slate,	3	65
Coal,	2	67
Sand, coarse, 2′ Sand, fine, 22′ } Pottsville, Sand, coarse, 93′	117	184
Slate, hard,	10	194
Slate, soft,	74	268
Slate, soft, red,	2	270
Sand, soft,	10	280
Slate,	90	370
Sand (salt water),	20	390
Slate,	49	439
Sand (salt water),	27	466
Slate, soft,	84	750
Slate, soft, red,	5	755
Sand, hard (first Venango)?	10	765
Slate, blue,	21	786
Slate, red,	29	815
Slate, blue,	77	892
Slate red,	2	894
Slate, brown,	31	925
Slate, hard and soft (oil),	45	970
Slate,	22	992

To the southeast of Sligo, no wells appear to have been drilled within Piney township.

Structure.—The structural contours of the surface rocks over this township show the Reidsburg syncline to cross it from east to west, near the middle. These show the whole of the township to be along the bottom and sides of a very broad, flat depression in the rock with a gentle downward slope of the rocks to the southwest. Within this broad, saucer-like depression, the bottom of the Reidsburg syncline seems to make a deeper, steeply pitching trough from the vicinity of Well 73 westward to the edge of the quadrangle.

From the records of wells drilled within this township and from the spirit-level lines to the mouths of these wells sufficient data have been secured to justify an attempt to contour the structure of the Hundred-foot sand over only a portion of the area. Over that portion in which these contours are shown (Green contours, Plate V.), it will be seen that the information is not sufficient to insure great accuracy. From it, however, the conclusion must be drawn that the structure of the oil sands is materially different from that shown of the surface rocks (Black contours, Plate V.) By the contours on the Hundred-foot sand a deep, steeply-pitching trough is shown a short distance west of Well 62, extending westward to the edge of the quadrangle. If this is the exact location of this trough, the gas pool in the vicinity of Well 76 and to the west occupies a rare structural position for accumulations of gas. With possibly a few exceptions, the other gas and oil wells of this township occupy normal structural positions.

No suggestions of value relative to the probable locations of other oil and gas pools within Piney township can be made without a more intimate knowledge of the structure and condition of the sand over this area.

LIMESTONE TOWNSHIP, CLARION COUNTY.

Limestone township lies east of Monroe and south of Clarion townships. This area has furnished practically no oil to date, and it is doubtful if any large pools occur here. It is, however, one of the most prolific gas-bearing areas of the quadrangle, and a large portion of the probably productive territory has not been developed. There is a reason for the belief that a number of good pools will yet be found in this territory.

George Gas Field.—This is a name tentatively applied by the writer to a gas field located on the north side of Little Piney Creek in the northwest quarter of the township. Probably the first well (No. 80) in this pool was drilled in 1883 on what is known as "the old gas tract," by Mr. A. A. Stewart of New Bethlehem. This well got gas in the Murrysville sand at about 600 feet and a little more in a sand at 900 feet. The total depth of the well was 1,320 feet and the closed pressure of gas, 200 pounds.

In the S. D. Orr No. 1 Well (No. 81) drilled in 1891, a gas-bearing sand was touched at a depth of 544 feet which had a thickness of 26 feet. In this well what is called the Third sand was found from 1,044 to 1,054 feet. The Fourth sand is here reported absent. The

Speechley was found from 1,957 to 1,963, and a "hard, black shell" at from 2,036 to 2,051 feet. This is possibly at the horizon of the Tiona sand. The well was finished at a depth of 2,602 feet. Its mouth is approximately 1,300 feet above sea-level. No mention is made of the Murrysville sand, or of the Hundred-foot sand in this well, but the Gas sand at 544 is probably one or the other of these beds. No statement of the initial rock or closed pressure of this well is available. When it had produced for almost two years, it was shut in for thirty days, at the end of which time the closed pressure was 108 pounds.

Well 82, which is No. 5, drilled on a farm then owned by either Joseph or Uriah George, has an elevation of 1,498 feet. If this is the Uriah George No. 5 Well, it got the Gas sand at 740 to 752 feet. This well had an initial capacity of 300,000 cubic feet per day. Several imperfect records of wells in this field are at hand, but in this instance sufficient elevations of wells were not secured to make them of much value in determining the structure of the gas sands.

Among the larger gas wells, the Uriah George No. 6 Well had an initial capacity of 2,000,000, No. 4 on the same farm made 1,500,000, and the G. W. George 500,000 cubic feet per day.

Greenville Gas Field.—The writer groups under this head the large number of small pools in the different sands that are located on the crest and flanks of the Kellersburg anticline from the southwest corner of the township west of Frogtown to the northern border in the vicinity of Rader. Throughout this section records very complete and reliable have been kept of a number of deep wells.

In Well 83, the S. J. Conner No. 1, located half a mile west of Rader, no sands are mentioned above the Speechley at 2,102 to 2,132. Below this at 2,417 feet, the Sheffield sand was found 18 feet thick, and at 2,880 another sand 11 feet thick was struck. No record of the Joseph Simpson No. 1 Well (No. 84) was secured. It has an elevation of 1,510 feet above sea-level. In the John Moyer No. 1 Well (No. 85), gas was found in the Hundred-foot and Speechley sands with an initial rock pressure of 830 pounds. The Hundred-foot in this well is 690 feet. The Hundred-foot sand is here very thin, being only about 10 feet thick. On plate II. is shown a section of the Anna A. White No. 1 Well (No. 86) which got gas in the Murrysville and Speechley sands with a closed pressure of 740 pounds. In both 85 and 86, the closed pressure of the upper sands probably does not exceed 400 pounds. The high pressure doubtless comes from the Speechley. Here is an instance where the closed pressures of gas in the same sand shows considerable variance within a short distance Well 86 came in April 21, 1907, and 85 came in July 17, 1907, yet the latter shows 90 pounds greater closed pressure. No mention is made in the records of the comparative porosities of the sand in the two wells. The mouth of Well 86 has an elevation of 1,408 feet.

The Wm. Smith No. 1 Well (No. 87) found gas in the Speechley, Tiona and Bradford sands with an initial closed pressure of 625 pounds. Well 88 on the A. E. Amsler farm is said to get gas from the Speechley sand. The top of the casing in this well is about 1,575 feet above the sea.

Record of Well 89, Stewart Snyder No. 1. Record furnished by the Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,551.

	Thickness.	From.	To.
Clay,	20	0	20
Mountain sand,	470	20	490
Slate and shells,	65	490	555
Sand,	30	555	585
Slate,	5	585	590
Sand,	100	590	690
Slate,	25	690	715
Murraysville sand,	57	715	772
Slate,	33	772	805
Hundred-foot sand,	17	805	822
Red rock,	10	822	832
Slate,	33	832	865
Thirty-foot sand (gas),	35	865	900
Slate,	7	900	907
Sand,	24	907	931
Slate,	81	931	1,012
Red rock,	28	1,012	1,040
Slate,	36	1,040	1,076
Red rock,	74	1,076	1,150
Slate,	15	1,150	1,165
Red rock,	7	1,165	1,172
Slate and shells,	18	1,172	1,190
Red sand,	10	1,190	1,200
Slate and shells,	75	1,200	1,275
Red rock,	37	1,275	1,312
Slate and shells,	758	1,312	2,070
Speechley sand (gas),	40	2,070	2,110
Slate and shells,	60	2,110	2,170
Tiona sand,	20	2,170	2,190
Slate,	110	2,190	2,300
Sand,	40	2,300	2,340
Slate and shells,	58	2,340	2,398
Bradford sand (gas 5 ft. in sand),	40	2,398	2,438
Slate, break in sand,	2	2,438	2,440
Bradford sand (second part of gas 15 ft. in sand),	45	2,440	2,485
Slate,	4	2,485	2,489

The above record is one of the best and most complete secured of wells within the Clarion quadrangle. A section plotted from this record is shown on Plate II., as is also one of Well 90 on the George Aaron farm which is very complete. The latter well went 43 feet below the Bradford sand, getting gas in the Speechley. Its mouth is 1,489 feet above sea-level.

Record of Well 91, S. E. and S. R. Spur No. 1. Record furnished by Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,471.

	Thickness.	From.	To.
Clay,	15	0	15
Sand,	80	15	95
Slate,	5	95	100
Mountain sand,	200	100	300
Slate,	10	300	310
Sand,	90	310	400
Red rock,	10	400	410
Slate and shells,	40	410	450
Red rock,	10	450	460
Slate and shells,	130	460	590
Slate,	58	590	648
Murraysville sand (gas),	32	648	680
Slate,	10	680	690
Hundred-foot sand,	84	690	774
Slate,	6	774	780
Red rock,	10	780	790
Slate and shells,	75	790	865
Red rock,	20	865	885
Slate,	15	885	900
Sand,	28	900	928
Slate,	12	928	940
Red rock,	56	940	996
Slate and shells,	27	996	1,023
Red rock,	127	1,023	1,150
Red sand,	22	1,150	1,172
Slate and shells,	62	1,172	1,234
Red rock,	41	1,234	1,275
Slate and shells,	125	1,275	1,400
Red rock,	25	1,400	1,425
Slate and shells,	380	1,425	1,805
Red rock,	19	1,805	1,824
Slate and shells,	211	1,824	2,035
Speechley sand (gas),	35	2,035	2,070
Slate and shells,	96	2,070	2,166
Tiona sand,	17	2,166	2,183
Slate,	193	2,183	2,376
Bradford sand (gas 15 ft. in sand),	46	2,376	2,422
Bradford sand, break of slate,	5	2,422	2,427
Bradford sand (gas),	56	2,427	2,483
Slate and shells,	68	2,483	2,551

Detailed records of the above type are far too rare, and their value in future geologic work cannot be estimated at this time, but it will doubtless be sufficient to justify the care taken to preserve them.

Record of Well 92, Orr Buffington Estate No.1. Record furnished by People's Natural Gas Co., Elevation, about 1,385. Drill completed January 4, 1904.

	Thickness.	From.	To.	
Stray or first sand,	20	700	720	Gas at 712. Gas at 790.
Murrysville sand,	60	780	840	Oil at 2,100.
Thirty-foot sand,	30	1,005	1,035	
Speechley sand,	38	2,090	2,128	Gas from Murrysville.
Total depth,			2,345	

No. 1, completed January 4, 1904.
Gas in Murrysville; initial rock pressure 110 pounds.

In the Orr Buffington Estate No. 1 Well (No. 92), as given above, there is a question as to the correlation of the first two sands. Assuming that the Speechley has geen correctly identified in this well (since it is usually easily recognized), the distance between it and the top of the Hundred-foot sand in several wells near No. 92 is from 1,330 to 1,345 feet, with an average of about 1,335. Applied to Well 92, this would give the Hundred-foot sand at about 755. It seems very probable from this and other evident comparisons that the sand called the Murrysville is really some part or all of the Hundred-foot sand, the Stray or First being the Murrysville. In this record, oil is mentioned as being in the Speechley. This is a rare occurrence, as this sand produces gas almost exclusively within the Clarion quadrangle.

Number 2 on the Buffington farm (93) has an elevation of 1,311 feet.

No elevation of the G. W. Rhodes No. 1 Well (94) is at hand. This well was drilled through the Bradford sands. It got gas in the Murrysville, Speechley, Tiona, First and Second Bradford sands, with an initial closed pressure of 855 pounds. The top of the Hundred-foot sand was touched at a depth of 715 feet. It was 40 feet thick and 1,335 feet above the top of the Speechley. This well was finished by the People's Natural Gas Co. January 3, 1907.

The Isaac Millar No. 1 Well (No. 95) got gas in the Murrysville (rock pressure 170 pounds). The Hundred-foot sand was found at a depth of 733 feet.

No levels were run to this well, or to No. 1 on the W. F. Craig farm (No. 96), which got gas from 600 to 632 feet in a sand said to be the Murrysville.

In the vicinity of the village of Limestone or Greenville, several wells have produced more or less gas. But one record of these, the J. E. Lucas No. 1 (No. 97) was secured. This well got gas in the Speechley and Bradford sands, which had an initial closed pressure of only 150 pounds, in comparison with that of 855 pounds in Well No. 94, which was drilled eight months later. Here is another instance where a variation in the closed pressure of over 700 pounds is found within a distance of one mile in what is very probably a continuous sandstone. The Hundred-foot here has an interval of 1,351 feet from the Speechley. The elevation of the well mouth is 1,495 feet.

Well 98, Mrs. J. Craig No. 1, has an elevation of 1,355 feet.

Wells 99 and 100 on the T. W. Craig property are respectively 1,278 and 1,271 feet above the sea-level.

Because of its completeness the record of Well 101 is given below.

Record of Well 101, N. P. Sloan. Record furnished by Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,501 feet.

	Thickness.	From.	To.
Clay,	38	0	38
Slate,	52	38	90
Sand,	90	90	180
Slate,	52	180	232
Mountain sand,	160	232	392
Slate,	30	392	422
Sand,	32	422	454
Slate,	36	454	490
Sand,	145	490	635
Slate,	140	635	775
Murrysville sand,	15	775	790
Slate,	20	790	810
Hundred-foot sand,	70	810	880
Slate,	12	880	892
Thirty-foot sand,	10	892	902
Slate,	64	902	966
Red sand (gas),	22	966	988
Slate,	10	988	998
Red sand and gas,	22	998	1,020
Slate and shells,	100	1,020	1,120
Red rock,	24	1,120	1,144
Slate and shells,	22	1,144	1,166
Red rock,	74	1,166	1,240
Sand,	26	1,240	1,266
Red rock,	19	1.266	1,285
Sand,	51	1,285	1,336
Slate and shells,	44	1,336	1,380
Red rock,	40	1,389	1,420
Sand,	20	1,420	1,440
Slate and shells,	95	1,440	1,535
Red rock,	20	1,535	1,555
Slate and shells,	614	1,555	2,169
Speechley sand (gas),	30	2,169	2,199
Slate and shells,	70	2,199	2,269
Tiona sand,	24	2,269	2,293
Slate and shells,	187	2,293	2,480
Bradford sand (gas 2 ft. and 15 ft. in sand),	30	2,480	2,510
Slate,	5	2,510	2,515
Sand,	10	2,515	2,525
Slate,	66	2,525	2,591

In this well it seems probable that what is called the Thirty-foot sand is really the lower section of the Hundred-foot, and the regular Thirty-foot is the "red gas sand" below. This correlation is more clearly brought out by the section made from this record in Plate II. It is to be regretted that the initial closed pressure in this well is not available.

In the N. P. Sloan No. 2 Well (No. 102), the top of the Hundred-foot sand was reached at a depth of 720 feet and the Speechley at 2,065. Gas was found in the Murrysville and Sheffield sands with an initial closed pressure of 400 pounds. No gas is mentioned in the Hundred-foot, Thirty-foot, Speechley or Tiona sands. This well was finished June 21, 1907, and has an elevation of about 1,415 feet. A short distance south of this well, No. 105 shows a considerable difference in the producing sands.

Record of Well 103, N. H. Sloan No. 1. Record furnished by the People's Natural Gas Company. Finished June 26, 1907. Elevation, about 1,508 feet.

	Thickness.	From.	To.	
Lime,		18	28	
Murrysville sand,		790	811	Gas from 795 to 805.
Hundred-foot,		825	915	
Thirty-foot,		970	1,015	
Speechley,		2,155	2,200	Gas from 2,166 to 2,176
Tiona,		2,270	2,305	
Sheffield,		2,400	2,420	Little oil at 2,410.
Bradford,		2,492	2,500	Gas from 2,495 to 2,498
Second Bradford,		2,551	2,562	Gas from 2,560.

Completed June 26, 1907. Gas at Murrysville, Hundred-foot and Bradford sands. Initial rock pressure 835 pounds.

In this well it will be noticed that the Sheffield sand produced a little oil which is the first to be noted in the wells discussed above. Also in this well, the Murrysville, Speechley and Bradford sands carry gas. It will be remembered that in Well 94 the Speechley or Bradford sand furnished the pressure of 855 pounds. In Well 95 the Bradford had a closed pressure of 330 pounds, and in Well 97 of only 150. This great variation cannot well be attributed to the varying amount of relief given to areas by former wells, because in these instances the wells with low pressure happen to have been drilled first. 'Neither can this variation be attributed to the difference in porosity of the pay streak, because the initial closed pressure is not effected by the capacity of the sand to hold gas at the point where it is penetrated by the well. This is also doubtless true of the thickness of the pay streak. The point which the writer wishes to impress is that this variation in the closed pressure of either the Bradford or the Speechley sand can have either of the following meanings:

That (1), the sand is not continuous from well to well, and that each is drawing from a separate pool; or (2) there are impervious barriers in this sand through which the gas cannot be forced at the maximum pressure (855 pounds); or (3) the gas in this sand is continuous from well to well, but that it is not under an equilibrial pressure due either to variation in the capacities of the sources of the gas, variation in rate of dissipation, of pressure at various points through leakage of reservoir, or the variation in degree of compression exercised on the gas body by some outside force.

In a practical way it means that the most sensible, as well as economical method of developing an area where two or more test wells show great variations in closed pressure, is by cautious extensions from each well. The writer is inclined to believe from his obseravtions that a great many gas pools have each a considerable variation in pressure from point to point, and that they are therefore not in a state of perfect equilibrium. Only by a systematic detailed investigation of the closed pressure over wide areas can geologists hope to settle this question finally. It is one, however, which very materially affects the practical side of the gas business, and a better knowledge of the factors governing closed pressures, it is thought, may furnish a very valuable indication of the existence and the location of undiscovered pools.

Well 104 on the John K. Campbell farm has an elevation of 1,346 feet. It is thought that the gas in this well comes from the Murrysville sand exclusively.

Record of Well 105, A. A. Stewart (formerly D. H. Parsons) Farm. Record furnished by Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,391.

	Thickness.	From.	To.
Clay,	64	0	64
Sand,	86	64	150
Slate,	15	150	165
Mountain sand,	200	165	365
Slate,	40	365	405
Sand,	22	405	427
Red rock,	8	427	435
Slate,	20	435	455
Red rock,	5	455	460
Slate and shells,	65	460	525
Sand,	10	525	535
Red rock,	5	535	540
Slate,	25	540	565
Sand,	35	565	600
Slate and shells,	90	600	690
Sand and shells (little gas),	15	690	705
Slate and shells,	45	705	750
Murrysville sand (show of gas),	45	750	795
Red rock,	15	795	810
Hundred-foot sand (salt water),	60	810	870
Slate and shells,	70	870	940
Thirty-foot sand,	20	940	960
Slate and shells,	8	960	968
Red rock,	10	968	978
Sand,	10	978	988
Slate and shells,	73	988	1,061
Red rock,	29	1,061	1,090
Slate,	5	1,090	1,095
Sand,	20	1,095	1,115
Red rock,	65	1,115	1,180
Slate,	4	1,180	1,184
Red rock,	18	1,184	1,202
Slate and shells,	28	1,202	1,230
Red rock,	30	1,230	1,260
Slate and shells,	12	1,260	1,272
Fourth sand,	24	1,272	1,296
Slate and shells,	80	1,296	1,376
Fifth sand,	34	1,376	1,410
Slate and shells,	85	1,410	1,495
Red rock,	35	1,495	1,530
Slate and shells,	512	1,530	2,042
Sand (little gas),	15	2,042	2,057
Slate,	73	2,057	2,130
Speechley sand,	32	2,130	2,162
Slate and shells,	73	2,162	2,235
Tiona sand (little gas),	20	2,235	2,255
Slate and shells,	130	2,255	2,385
Gray sand,	20	2,385	2,405
Slate and shells,	40	2,405	2,445
Second Bradford sand (little oil and salt water),	83	2,445	2,528
Slate and shells,	34	2,528	2,562

In Well 105, it will be noticed from the above record, that a little oil with salt water was found in the Bradford sand, at a point 150 feet higher on the sand than it was found in Wells 45 and 46 on the north side of the Rimersburg anticline in Monroe township. In both instances, however, the occurrence is well down towards the trough of a syncline.

Nothing is known of Well 106 except that it is on the Frank Hepler farm, was once owned by John A. McGee, and has an elevation of 1,417 feet.

Structure.—The structural contours of the surface rocks over Limestone township show that the Kellersburg anticline is the dominant feature in this area. The structure of the Hundred-foot sand as depicted by the green contours, Plate V, also gives great prominence to this anticline and especially to the high dome in it at the north edge of the township. From the steeply pitching axis of this fold south of this point, the dip of the rocks is uniformly rapid to the west, northwest and to the southeast. The only break in this monotonous dip is that made by the southwest projection of the secondary Rimersburg anticline which joins the Kellersburg in the southwestern portion of the township. Southeast of the Rimersburg anticline and west of the Kellersburg, the Brady's Bend syncline dies out as a broad, flat, steeply-pitching trough, in the vicinity of Well 105.

From a study of the structure of this township and with the additional data that are given above or may be secured in the field, the gas producers operating in this field can doubtless make more satisfactory locations for future wells than the writer. There seems to be a considerable amount of good gas territory in this township which is tested only sufficiently to prove its value. This will very probably be the source of a large gas production in the future, though none of the wells will have a remarkable large daily production.

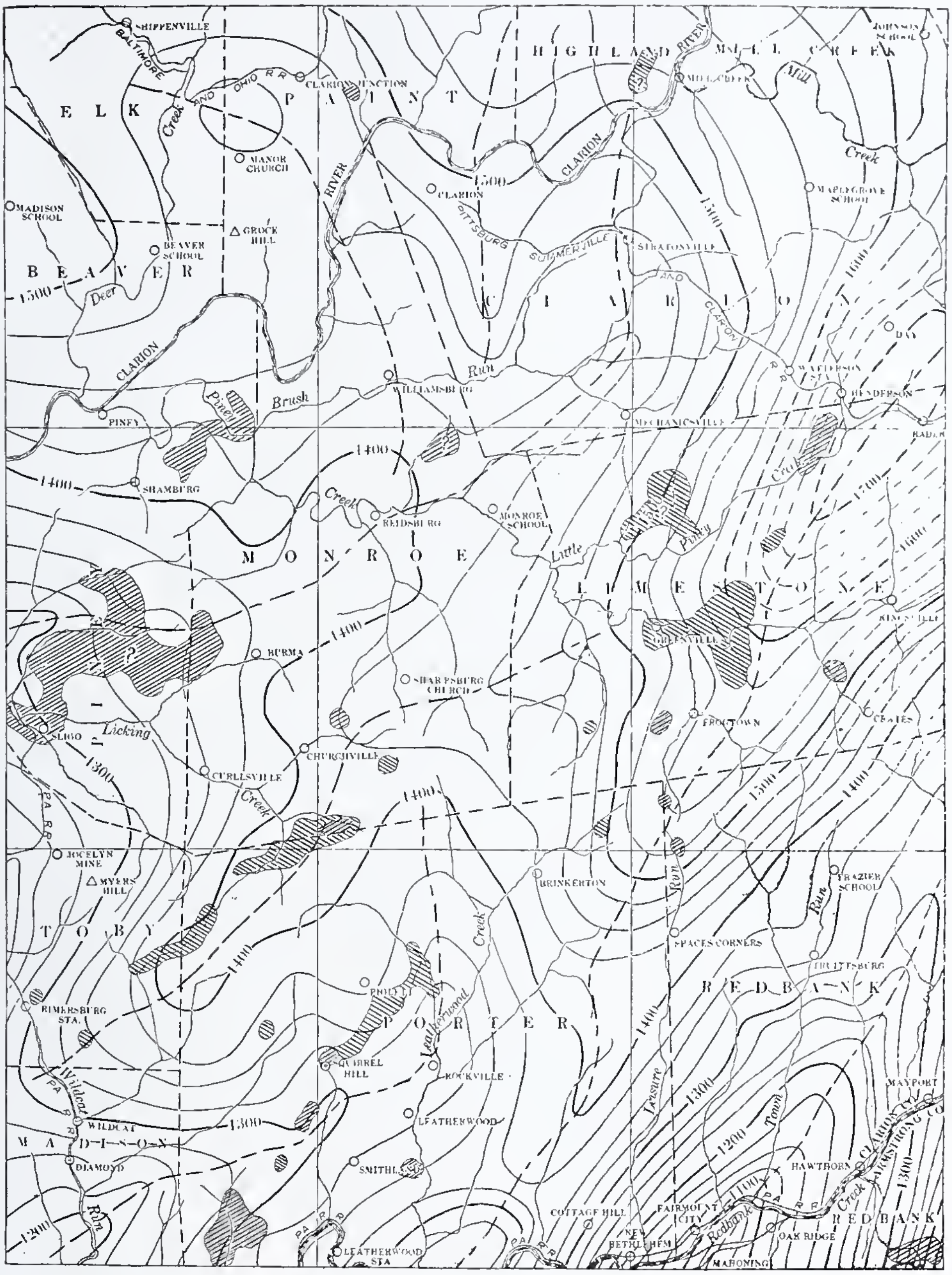
There is probably little show of this area furnishing much oil, though small pools in the Third and Fourth sands may be found somewhere along the western edge of the quadrangle north of the axis of the Rimersburg anticline.

RED BANK TOWNSHIP, CLARION COUNTY.

Red Bank township lies south of Limestone township and north of Armstrong county, only the western part of the township being in the Clarion quadrangle.

Within this area less than a dozen deep wells have been drilled. While most of these have produced some gas, they have been very moderate wells, and their total output has been comparatively small.

In the northwestern corner of this township, Well 107 on the M. T. Bodenhorn farm got a showing of gas both in the Hundred-foot and Thirty-foot sands, but was drilled 509 feet below the Speechley sand without finding gas in paying quantities.



LOCATION OF KNOWN OIL AND GAS POOLS IN THE MURRYSVILLE AND HUNDRED-FOOT SANDS IN THE CLARION QUADRANGLE.

▨	▨	▨
Murrysville sand.	Murrysville and Hundred-foot sand.	Hundred-foot sand.

Contours are drawn on Lower Kittanning coal

Datum plane is sea level.

Record of Well 107, M. T. Bodenhorn Farm. Record furnished by Apollo Gas Company, W. A. Louden, contractor. Elevation, 1,495.

	Thickness.	From.	To.
Clay,	11	0	11
Lime,	6	11	17
Clay,	33	17	50
Slate,	40	50	90
Mountain sand,	175	90	265
Broken slate,	15	265	280
Broken sand,	176	280	456
Red rock,	5	456	461
Slate and shells,	131	461	592
Sand,	20	592	612
Slate,	145	612	757
Campbell sand,	15	757	772
Slate,	30	772	802
Murraysville sand,	35	802	837
Slate,	23	837	860
Hundred-foot sand (a little gas),	10	860	870
Slate,	75	870	945
Thirty-foot sand (gas 12 ft. in sand),	30	945	975
Red rock,	40	975	1,015
Slate and shells,	71	1,015	1,086
Red rock,	30	1,086	1,116
Slate and shells,	156	1,116	1,272
Fourth sand,	30	1,272	1,302
Slate and shell,	93	1,302	1,395
Fifth sand,	15	1,395	1,410
Slate and shells,	723	1,410	2,133
Speechley sand,	52	2,133	2,185
Slate,	65	2,185	2,250
Sand,	20	2,250	2,270
Slate and shells,	126	2,270	2,396
Sand,	15	2,396	2,411
Slate,	43	2,411	2,454
Sand,	82	2,454	2,536
Slate,	6	2,536	2,542

The following record of Well 108 is given in order to show the data relative to structural lines on the Hundred-foot sand in this locality:

Record of Well 108, B. B. Ferguson No. 1. Record furnished by the People's Natural Gas Co. Elevation, 1,491.

	Thickness.	From.	To.
Sand,		140	175
Water well,			189
Big Injun,		400	555
Big Injun,		650	680
Murraysville,		850	900
Hundred-foot,	61	930	1,001
Gas at			930
Thirty-foot,		1,320	1,330
Thirty-foot,		1,625	1,690
Stray,		2,000	2,015
Speechley,		2,160	2,200
Tiona,		2,313	2,333
Sheffield,		2,480	2,490
Sheffield,		2,510	2,565
Gas at			2,555
Broken sand,		2,572	2,765
Total depth,			2,779

Completed July 25, 1906.
Gas in 100-foot and Sheffield sands.
Initial rock pressure, 405 pounds.

In this well the distance from the top of the Hundred-foot to the top of the Speechley sand is 1,230 feet. In Well 107, it was given as 1,273 feet, in a number of the wells in Limestone township farther to the north this distance averaged 1,335 feet and in Well 109 it is given as 1,330 feet. In making comparisons from well records, it is very difficult to correlate satisfactorily the Pocono sands above the Murrysville. In Well 108 it seems, however, that the distance between the bottom of the Big Injun and he top of the Murrysville sand (95 feet) is too small. In wells 107, 109, and 110, this distance is given as 346, 315 and 310 feet, respectively. While the above data are by no means conclusive it seems that the distance between the Big Injun and Speechley is at least 300 feet shorter than it is usually found. If these measurements are by steel line and approximately exact, what is called the Murrysville is probably the Hundred-foot.

Record of Well No. 109, Mrs. Chrissie Raybuck. Record furnished by Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,627.

	Thickness.	From.	To.
Slate and shells,	160	0	160
Lime,	8	160	168
Slate,	32	168	200
Coal,	3	200	203
Slate,	97	203	300
Mountain sand,	300	300	600
Slate and shells,	315	600	915
Murrysville sand (gas at 920),	38	915	953
Slate,	27	953	980
Hundred-foot sand,	105	980	1,085
Slate and shells,	15	1,085	1,100
Red rock,	5	1,100	1,105
Slate and shell,	50	1,105	1,155
Red rock,	445	1,155	1,600
Slate and shells,	710	1,600	2,310
Speechley sand,	50	2,310	2,360
Slate,	80	2,360	2,440
Tiona sand (hard),	12	2,440	2,452
Slate and shells,	345	2,452	2,800
A soft sand at 2,810 (gas),	15	2,800	2,815
A lime slate,	200	2,815	3,015

In Well 109 it will be noticed that the Thirty-foot, Third, Fourth and Fifth sands are replaced by slate and shells (shale and thin sandstone layers) and that slate and shells also fill the interval below the Tiona sand usually occupied by the Sheffield and Bradford sands, unless the "soft sand" at 2,800 represents the lower Bradford.

Record of Well 110, Scott B. Ditty No. 1. Record furnished by Apollo Gas Company. Elevation about 1,315.

	Thickness.	From.	To.
Mountain Sand,		25	530
Murrysville,		340	875
Hundred-foot,		890	960
Thirty-foot,		973	1,000
Sheffield,		2,619	2,657
Bradford (gas in top and bottom of sand),		3,030	3,120

In Well 110 it will be noted that the distance between what is called the Hundred-foot and the Sheffield and Bradford sands is 200 to 500 feet greater than it is in the vicinity of Frogtown, Limestone township. So far as can be determined, the upper sands are correctly named in this well, but it is very doubtful if the lower sands really represent the true Sheffield and Bradford horizons.

No record was obtained of the L. Rhodes No. 1 Well (111.) It has an elevation of 1,335 feet.

Southeast of wells 110 and 111 no deep holes appear to have been drilled nearer than Wells 112, 113 and 114. The writer is not certain that a well was drilled at the location of 112. The record of well 113 on the A. J. Shick farm gives limestone at a depth of 150 feet and the Murrysville at 990. The elevation of this well is 1,165 feet. If the sand at 990 is the Murrysville and the Hundred-foot is at its normal position below, there can not be less than 30 feet between the tops of these sands. This would put the top of the Hundred-foot at 1,020 which seems to be 100 feet or more too low, if the structure of the Hundred-foot follows in a general way that of the surface rocks.

Well 114 was drilled on the John and Jacob Gruber farm about 1862 or 1863. It is said to have been a dry hole.

The following record of the Jacob Brinker No. 1 Well is thought to belong to No. 115.

Record of Jacob Brinker No. 1. Well (115). Second Geological Survey of Pennsylvania, Vol. III., p. 410. Elevation, 1,080 (given by the above Survey).

	Thickness.	Depth.
Conductor, to	8	8
Limestone, Ferriferous,	2	10
Coal,	1	11
Sand, black,	18	29
Coal,	3	32
Sand, black,	4	36
Slate,	40	76
Shells,	2	78
Slate,	33	111
Sand, white,	3	114
Slate,	32	146

Record of Jacob Brinker No. 1 Well—Continued.

	Thickness.	Depth.
Coal,	1	147
Slate,	4	151
Coal,	2	153
Slate,	17	170
Coal,	4	174
Slate,	44	218
Sand, gray,	10	228
Slate,	2	230
Sand, white,	57	287
Slate,	24	311
Sand, "mountain sand,"	251	562
Red rock,	15	577
Sand, white,	10	587
Slate, shelly,	75	662
Sand, white (gas),	20	682
Slate, with shells,	128	810
Pebble shell,	1	811
Slate,	10	821
Shell, white,	5	826
Slate,	12	838
Sand, pebble,	10	848
Slate,	8	856
Sand, white (Murrysville?),	14	870
Slate,	2	872
Sand, white (Hundred-foot),	80	952
Sand, gray (Hundred-foot),	20	972
Sand and slate,	18	990
Red rock,	5	995
Slate, shelly,	135	1,130
Red rock,	22	1,152
Slate and gray shells,	33	1,185
Slate,	11	1,196
Red rock,	4	1,200
Slate, shelly,	10	1,210
Red rock,	43	1,253
Shell,	1	1,254
Slate,	30	1,284
Shells and slate,	24	1,308
Shell,	3	1,311
Red rock,	5	1,316
Slate, shelly,	7	1,323
Sand,	9	1,332
Slate,	8	1,340
Shells and slate,	10	1,350
Sand,	5	1,355
Slate, shelly,	40	1,395
Red rock,	45	1,440
Red mud,	5	1,445
Slate, blue,	105	1,550
Red rock,	60	1,610
Shells and blue slate,	100	1,710
Red rock, very pale,	5	1,715
Shell and blue slate,	10	1,725
Sand, gray, "Drillers' First Sand,"	40	1,765
Slate and shells with red streaks,	110	1,875
Sand, gray (show of oil and gas), "Second sand,"	45	1,920
Slate blue,	30	1,950
Sand, shell, light gray,	4	1,954
Shells and blue slate,	56	2,010
Pebble shell,	1	2,011
Slate and shells,	21	2,032
Shell, gray,	4	2,036
Shells and blue slate,	27	2,063
Sand, shell,	6	2,069
Shells and blue slate,	39	2,108
Sand, white,	10	2,118
Slate, blue,	4	2,122
Pebble shell,	2	2,124
Shells and blue slate,	42	2,166
Sand (gas and oil show), "Stray,"	60	2,226
Slate, blue,	22	2,248
Slate, blue,	32	2,280

By a comparison of this record with the average section of wells, Plate II., and assuming that the Murrysville sand is correctly named, it will be seen that the sand at 1,765 in the record corresponds closely to the thin sandstone immediately underlying the first streak of red rock shown in the section below the Fifth sand, and that the "Second Sand" of the record is about the same horizon as the one below this bed of red rock. It seems probable that the sand from 2,166 to 2,226 is the Speechley, though it may possibly correspond to the "Stray" above this sand.

A well drilled on the John Miller farm a short distance northeast of New Maysville is off the eastern boundary of the quadrangle. Levels run to the mouth of this well show it to have an elevation of 1,259 feet. No record of the well is at hand.

So far as the writer could learn by assiduous inquiry, no other wells have been drilled within this township.

Structure.—Structural contours on the Lower Kittanning coal, Plate IV., show that the axis of the Fairmount syncline crosses the southern edge of the township near Fairmount City with a northeast trend and cuts the eastern border of the quadrangle, northeast of Truittsburg. The axis of this syncline pitches steeply to the southwest. Northwest from this trough, the rocks rise rapidly to the crest of the Kellersburg anticline in the northwest corner.

Owing to the scanty well information, the structure of the Hundred-foot sand is contoured over only a portion of the northwest part of the township. In this area, the structure of the surface and underground beds does not differ materially.

Little is known of the prospects for oil and gas in this township, but from the available data there seems to be poor chance of finding large pools of either, the greatest obstacle apparently being in the quality of the sands rather than unfavorable structure. This is especially true as regards oil.

RED BANK AND MAHONING TOWNSHIPS, ARMSTRONG COUNTY.

Only small portions of Red Bank and Mahoning townships, Armstrong county, are embraced by the Clarion quadrangle southeast of Red Bank Creek. Of the small triangular area in Armstrong township lying to the southeast of New Bethlehem, no geologic information of any kind was obtained. In Red Bank township, a group of wells have been drilled for gas in the extreme southeast corner of the quadrangle. The records of only two of these wells were obtained, both of which are very incomplete and of little geologic value. These records are given below:

Record of Well 116, J. B. Shirley No. 14. Record furnished by Pennsylvania Fuel Supply Co. Elevation, 1,483.

	Thickness.	From.	To.
Casing 10",		900	
Tubing,		1,190	
Lime,		1,134	
Gas,		1,139	

Record of Well 117, J. B. Shirey No. 15. Record furnished by Pennsylvania Fuel Supply Co. Elevation, 1,475.

	Thickness.	From.	To.
Coal,		60	
Lime,		134	
Casing,		475	
Murrysville,		1,020	
Hundred-foot,		1,052	
Gas,		1,120	
Depth,			1,139
(Nearest to house.)			

In this field elevations on the following wells were obtained:

Elevations on wells in Red Bank township, Clarion county.

Farm Name.	Elevation.
J. B. Shirey, No. 3,	1,530
Samuel Lanhard, No. 1,	1,529
Daniel Lanhard, No. 2,	1,490
Samuel Lanhard, No. 1, (?),	1,420
W. H. Lanhard, No. 1, (?),	1,293
W. H. Lanhard, No. 2, (?),	1,285

Record of Well 118, J. T. Walker No. 19. Record furnished by Pennsylvania Fuel Supply Company. Finished February 19, 1904. Elevation, 1,242.

	Thickness.	From.	To.
Started at 28 feet below Vanport limestone.			
Red rock,		20	
Slate and shale,		1,750	
Red rock,	10		
Stray sand,		2,108	
Slate,		2,127	
Speechley sand,		2,172	2,194
Tiona,	6	2,298	

It will be seen that the only recognizable horizons mentioned in this record are the Speechley and Tiona sands and no stratigraphic proof is given that these are correctly identified. If the distance from the top of the Speechley to the top of the Hundred-foot is 1,330 feet here as at Well 110, the latter sand is at a depth of 842 feet, or 300 feet above sea-level. This elevation is very questionable.

One of the first wells drilled in this region is said to have been put down on the Andrew Waltman farm on the south side of Red Bank Creek in New Mayville, just off the quadrangle to the east. Nothing of geologic value is available regarding this well.

From the available data the contours of the Hundred-foot sand cannot be drawn with sufficient accuracy to be of value, and for the same reason suggestions regarding the possible location of oil or gas pools would be worthless.

PORTER TOWNSHIP, CLARION COUNTY.

Porter township lies west of Red Bank township and borders Red Bank Creek on the south. A number of the best gas producing areas in the Clarion quadrangle are located within this township.

New Bethlehem Gas Field.—This field is located from one to two miles west and northwest of New Bethlehem on the crest and flanks of the Kellersburg anticline.

Record of Well 119, W. W. Truett, No. 1 (?). Furnished by Pennsylvania Fuel Supply Company. Elevation, 1,156.

	Thickness.	From.	To.
Mountain sand,		229	240
Slate,	30	240	270
Sand with salt water,	27	270	297
Slate and red rock,	243	297	540
Sand,	20	540	560
Slate and shells,	190	560	750
Black sand,	10	750	760
Red sand,	10	760	770
Black sand,	20	770	790
White sand,	40	790	830
Slate and shells,	210	830	1,040
Sand,	30	1,040	1,070
Slate,	35	1,070	1,105
Red rock,	25	1,105	1,130
Sand,	25	1,130	1,155
Red rock,	20	1,155	1,175
Sand,	30	1,175	1,205
Red rock,	25	1,205	1,230
Sand,	30	1,230	1,260
Slate,	5	1,260	1,265
Sand,	10	1,265	1,275
Red rock,	5	1,275	1,280
Sand,	5	1,280	1,285
Slate,	2	1,285	1,287
Sand and slate,	38	1,287	1,325
Slate and shells,	95	1,325	1,420
Sand,	30	1,420	1,450
Slate and shells, 30 or 40 feet below lime.	186½	1,450	1,636½

In this record the black sand at 770 is considered the top of the Hundred-foot, and the black sand above at 750 is probably the Murrysville. The Third is probably at 1,175 to 1,205.

Record of Well 120, Charlie Lower No. 1 (?). Record furnished by the Canton Tile Hollow Brick Co. Elevation, 1,148.

	Thickness.	From.	To.
Indian,		16	315
Salt water,		457	500
Casing,		530	
Sand,		650	
Little oil,		662	
Break,		675	
Red rock,		690	
Murraysville (Hundred-foot),		*695	
Break,		735	
Sand,		825	
Break,		830	
Red rock,		853	
Break,		950	
Red rock,		978	
One screw sand,		1,170	
Sand,		1,200	
Little gas,		1,205	
Break,		1,240	
Speechley sand,		2,060	
Break,		2,110	
Bradford sand,		2,475	
Break,		2,510	
Kane, sand,		2,650	
Total,		2,775	

*695+55=750=top 100-ft.
A very small amount of gas in Speechley.
Not a good well.

In Well 120 the sand called the Murrysville seems to be more nearly at the horizon of the Hundred-foot. The one carrying the oil at 650 is probably the Murrysville.

Well 121 on the Valentine Miller farm has an elevation of 1,318 feet. The record of this well is poor and of little geologic value. Gas was found in it at a depth of 1,340, in a sand 10 feet thick, supposed to be the Third or the Stray above the Third sand.

Well 122 is called the "Little Jerry" Well No. 35. It has a depth of 1,300 and an elevation of 1,295 feet. To the northwest of 122 are a number of gas wells on the Wm. White farm of which no data was secured.

Well 123 on the Henry Beck farm has an elevation of 1,342. The top of the Second sand in this well is given as 780, the Thirty-foot at 1,010, Third at 1,211 and Fourth at 1,341 feet. Gas was found at 600, 790 and 1,015 feet from the top.

Well 124 on the Isaac or Wm. Musser farm has an elevation of 1,427. In this well the top of the First sand is given by the record as 850 feet, the Second at 900, Thirty-foot at 1,100, Third (shells) at 1,280 and Fourth at 1,450 feet from the surface. In this well the Second sand furnishes gas.

The following record of Well 125 shows the difficulty of correlating the sands of the three wells:

Record of Well 125, David Beaty No. 18. Record furnished by the Pennsylvania Fuel Supply Co. Elevation, 1,457.

	Thickness.	From.	To.
First coal,		30	
Second coal,		80	
Third coal,		138	
Lime,		295	
First sand (gas),	80	690	
Second sand,	20	1,100	
Fourth sand,	10	1,608	
Depth,			1,710

Because of the structural positions of these wells it is to be regretted that the records are not more complete.

Off the southern border of the quadrangle, less than a mile southwest of Well 122, the following record of a well on the farm of J. G. Shoemaker gives a fair idea of the stratigraphy of the underground rocks of this area.

Record of J. G. Shoemaker. Record furnished by Pennsylvania Fuel Supply Company. Finished December 15, 1905. Elevation, 1,229.

	Thickness.	From.	To.
Sand top fire clay,		28	
Fireclay,		31½	
Big Injun,	318½	31½	350
Slate,	20	350	370
Broken sand,	50	370	420
Red rock,	40	420	460
Slate and shells,	20	460	480
First sand, broken,	30	480	510
Slate,	90	510	600
Black sand,	25	600	625
Slate and shells,	20	625	645
Gas at,		650	
Murrysville, broken,	55	645	700
Gas at,		705	
Sand (reddish, hard), Hundred-foot? 55	100	700	800
Slate and shale,	175	800	975
Red Rock,	30	975	1,005
Sand (gray, hard),	15	1,005	1,015
Red rock,	170	1,015	1,185
Fourth sand,	30	1,185	1,215
Slate and shells,	45	1,215	1,260
Red rock,	30	1,260	1,290
Slate and shells,	765	1,290	2,055
Speechley sand (gray and hard),	100	2,055	2,155
Slate and shells,	115	2,155	2,270
Tiona,	25	2,270	2,295
Slate and shells,	39	2,295	2,334
Depth,			2,334

Dry hole.

In this record the sand at 645 is correctly termed the Murrysville, which here seems to be united with the Hundred-foot. The sand at 1,005 is the Third with an interval of 305 feet from top of Hundred-foot. It will be noticed that an unusual thickness of red rock here separates the Third sand from the Fourth, which is 485 feet below the Hundred-foot. The distance between the Fourth and Speechley sands is about 30 feet greater than the average as shown on Plate II. From the top of the Speechley to the top of the Hundred-foot is 1,355 feet.

Leatherwood Gas Field.—This name is applied to the line of gas wells extending from the vicinity of Leatherwood Station on Red Bank Creek northeastward to the village of Leatherwood.

Wells 126 and 127 at the southern end of this field are Nos. 1 and 2 on the W. N. Wiant farm at elevations of 1,161 and 968 respectively. The records of neither of these wells could be found.

A well on the Irwin Pence farm off the quadrangle less than a mile southeast of Well 126 has an elevation of 1,298 feet. The above wells are in Madison township, Armstrong county.

Record of Well 128, James Hamilton No. 1. Record furnished by the Canton Tile Hollow Brick Company. Elevation, 1,433.

	Thickness.	From.	To.
Black slate,		0	60
Limestone, blue, hard,	5	60	65
Slate, black, soft,	35	65	90
Sand, white, soft,	60	90	150
Slate, black, soft,	45	150	195
Sand, white, hard and soft,	160	195	355
Slate, black, soft,	30	355	385
Sand, white, hard,	175	385	560
Slate and shells, white, soft,	175	560	735
Sand, gray, hard,	20	735	755
Slate and shells, gray, hard,	135	755	890
Sand, dark,	15	890	905
Slate and shells, dark,	45	905	950
Sand, white,	70	950	1,020
Slate, dark, soft,	10	1,020	1,030
Sand, black, hard,	20	1,030	1,050
Slate and shells, black and soft,	75	1.050	1,125
Sand, gray, very hard, boulder,	5	1,125	1,130
Shells and rock, black soft,	110	1,130	1,240
Red rock, red, soft and hard,	50	1,240	1,290
Slate and shells, black, hard and soft, fourth sand,	50	1,290	1,340
Sand, dark, gray, hard,	10	1,340	1,350
Slate, black, soft,	10	1,350	1,360
Red rock, red, hard and soft,	50	1,360	1,410
Gas,		1,400	
Sand, gray, very hard,	55	1,410	1,465
Fifth,		1,410	
Slate and shells, black and soft,	50	1,465	1,515
Red rock, hard, soft,	25	1,515	1,540
Slate and shells, black, hard shells,	510	1,540	2,050
Slate, white, soft,	150	2,050	2,200
Sand, black, soft,	20	2,200	2,220
Slate and shells, hard, soft,	25	2,220	2,245
Sand, gray, hard,	10	2,255	2,265
Slate and shells, black, soft,	47	2,265	2,312
Speechley sand, dark, soft,	15	2,312	2,327
Total,			2,341

In Well 128 the Murrysville and Hundred-foot sands are those noted at 890 and 950 respectively. The sand called the Fourth is really the Third, the 65-foot sand below being the Fourth. The Speechley is probably correctly named. No statement is made of the closed pressure of this well, but the minute pressure shows it to be a good gas producer.

Well 129 is No. 1 on the J. K. Campbell farm. The record of this well shows practically the same horizons and intervals between them as Well 128. In this well coal was found at 60 feet, some gas in the lower section of the Hundred-foot, and the main flow in the Speechley, with an initial closed pressure of 800 pounds. What is called the Murrysville in this record is very probably the top of the Hundred-foot, the former sand being represented by "shells." The elevation of this well is 1,302 feet.

Well 130 on the J. F. Campbell farm has an elevation of 1,229 feet.

Well 131 on the J. M. Pence farm got the Murrysville sand at 730 and the lower section of the Hundred-foot with gas from 825 to 880, and the Fourth sand at 1,230. The top of the Hundred-foot is estimated at 785. The elevation of this well is 1,202 feet.

Well 132 on the John Fosh farm has an elevation of 1,252 feet. In the record of this well, lime is given at 90, Murrysville sand at 760, salt sand at 1,140 and sand at 1,200; total depth, 1,252. If the Murrysville sand is correctly named here, the top of the Hundred-foot is about 820 feet or 1,432 feet above sea-level.

Well 133 on the Gordon McNutt farm occupies a strategic structural position and it is to be regretted that the following record of this well is not more complete:

Record of Well 133, Gordon McNutt No. 19. Record furnished by the Pennnsylvania Fuel Supply Company. Elevation, 1,224.

	From.
Coal,	60
Coal, 4th and 5th.	150
Mountain sand,	400
Salt water,	600
First sand,	725
Second sand,	765
Thirty-foot sand,	1,010
Third,	1,200
Fourth sand,	1,260
Gas at,	1,268
Fourth sand,	1,290
Depth,	1,503

A comparison of the plotted section of this well with the average section of Plate II and also of typical sections of this vicinity, shows that the top of the Hundred-foot is probably 765 feet as given on the

Second sand which is at a height of 469 feet above sea-level. There can be little doubt that if this is not the top of the Hundred-foot, that horizon is not below a depth of 765 feet in his well.

Blair Gas Field.—This name is applied to the group of gas wells in the vicinity of Blair schoolhouse near the southern edge of the quadrangle. Of these wells, 134 on the Johnson farm (formerly L. & J. Blair) was drilled through the Fourth sand, getting a show of gas in the Hundred-foot and salt water in the Murrysville. This well has an elevation of 1,267 feet, the top of the Hundred-foot being at a depth of 952, and the Fourth at 1,333 feet.

All the wells of this field were drilled for the Apollo Gas Company by Mr. W. A. Louden, Contractor, and the records are exceptionally complete and reliable. Those given below show the stratigraphic value of such data.

Record of Well 135, Calvin Blair No. 2. Record furnished by Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,379 feet.

	Thickness.	From.	To.
Clay,	20	0	20
Coal,	3	20	23
Soft slate, coal,	15	23	38
Slate,	14	38	52
Lime,	8	52	60
Slate,	140	60	200
Sand, Mountain,	375	200	575
Slate,	8	575	583
Sand,	40	583	623
Slate,	10	623	633
Sand, salt water,	8	633	641
Slate,	10	641	651
Sand,	40	651	691
Slate,	30	691	721
Sand,	45	721	766
Slate and shell,	165	766	931
Murrysville sand,	20	931	951
Slate,	5	951	956
Sand,	15	956	971
Slate,	68	971	1,039
Hundred-foot sand,	23	1,039	1,062
Slate,	19	1,062	1,081
Sand,	25	1,081	1,106
Slate,	18	1,106	1,124
Thirty-foot sand,	26	1,124	1,150
Slate and shells,	75	1,150	1,225
Slate and red rock,	20	1,225	1,245
Slate and shell,	166	1,245	1,411
Sand,	8	1,411	1,419
Slate,	21	1,419	1,440
Fourth sand (show of gas),	32	1,440	1,472
Slate and shells,	199	1,472	1,671

Record of Well 136. Mrs. L. J. Simpson. Record furnished by Apollo Gas Company, W. A. Louden, contractor. Elevation, 1,286.

	Thickness.	From.	To.
Gravel,	28	0	28
Slate,	44	28	72
Sand, Mountain,	90	72	162
Slate,	20	162	182
Sand,	25	182	207
Slate,	5	207	212
Sand,	125	212	337
Slate,	10	337	347
Sand, black,	25	347	372
Sand, white,	78	372	450
Slate,	30	450	480
Sand,	25	480	505
Slate,	15	505	520
Red rock,	10	520	530
Slate and shells,	20	530	550
Sand,	36	550	586
Slate and shells,	34	586	620
Sand,	54	620	674
Slate,	141	674	815
Slate and shells,	35	815	850
Murrysville sand,	40	850	890
Slate,	15	890	905
Sand, salt water,	10	905	915
Slate,	41	915	956
Hundred-foot sand (show of gas and more salt water),	67	956	1,023
Slate,	16	1,023	1,039
Sand,	17	1,039	1,056
Slate, shells and red rock,	117	1,056	1,173
Slate, white,	17	1,173	1,190
Slate, shell and red rock,	166	1,190	1,356
Fourth sand (15 ft. of good sand),	28	1,356	1,384
Slate,	35	1,384	1,419

As an example of what the better class records can be made to show of local changes in the stratigraphy of the deeply buried strata, and also as a test of the ability of the intelligent driller to classify his rocks and correlate the sands through which his drill passes, the following records are given for such detailed comparisons as the reader may wish to make.

Record of Well 137, Calvin Blair No. 1. Record furnished by the Apollo Gas Company, W. A. Louden, contractor. Elevation, 1,331.

	Thickness.	From.	To.
Conductor,	31	0	31
Slate,	9	31	40
Sand, water,	10	40	50
Slate,	10	50	60
Sand,	25	60	85
Slate,	25	85	110
Mountain sand,	90	110	200
Slate,	20	200	220
Sand,	175	220	395
Slate,	10	395	405
Sand,	35	405	440
Slate,	5	440	445

Record of Well 137, Calvin Blair No. 1—Continued.

	Thickness.	From.	To.
Sand,	37	445	482
Slate,	77	482	559
Sand,	10	559	569
Slate,	8	569	577
Sand,	10	577	587
Slate,	5	587	592
Sand,	38	592	630
Slate,	10	630	640
Sand,	60	640	700
Slate,	80	700	780
Sand,	45	780	825
Slate,	25	825	850
Hard shells,	15	850	865
Slate,	31	865	896
Murrysville, gas and salt water,	41	896	937
Slate,	40	937	977
Sand,	13	977	990
Slate,	10	990	1,000
Sand, Hundred-foot,	10	1,000	1,010
Slate,	9	1,010	1,019
Sand, (gas 19 ft.),	25	1,019	1,044
Slate,	1	1,044	1,045
Sand,	31	1,045	1,076
Slate,	18	1,076	1,094
Sand,	8	1,094	1,102
Slate,	27	1,102	1,129
Sand,	25	1,129	1,154
Slate,	5	1,154	1,159
Red rock,	5	1,159	1,164
Slate,	15	1,164	1,179
Red rock,	5	1,179	1,184
Sand,	4	1,184	1,188
Red rock,	27	1,188	1,215
Slate,	28	1,215	1,243
Red rock,	42	1,243	1,285
Slate,	28	1,285	1,313
Red rock,	10	1,313	1,323
Sand,	12	1,323	1,335
Red rock,	34	1,335	1,369
Slate,	5	1,369	1,374
Shells and slate,	19	1,374	1,393
Fourth sand,	22	1,393	1,415
Slate,	17	1,415	1,432
Drilled deeper from 1,432.			
Red rock,	104	1,432	1,536
Limy sand,	239	1,536	1,775
Slate and shell,	75	1,775	1,850
Red rock,	10	1,850	1,860
Slate and shell,	261	1,860	2,121
Speechley sand,	9	2,121	2,130
Slate and shell,	122	2,130	2,252
Tiona sand,	25	2,252	2,277
Slate,	41	2,277	2,318
Sand,	46	2,318	2,364
Slate,	101	2,364	2,465
Sand,	10	2,465	2,475
Slate,	19	2,475	2,594
Bradford sand,	41	2,594	2,635
Slate,	42	2,635	2,677

A section of Well 137 is also given on Plate II. In this section it will be seen that the first five sands encountered below the Murrysville sand are considered parts of the Hundred-foot, separated by shale "breaks." In wells 135 and 136, the writer is somewhat inclined to consider the sand below the "break" in the Murrysville as a part of the Hundred-foot. This is, however, a difficult point to settle definitely.

Record of Well 138, Calvin Blair No. 3. Record furnished by Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,394.

	Thickness.	From.	To.
Clay and gravel,	30	0	30
Slate,	10	30	40
Lime,	10	40	50
Slate and shell,	175	50	225
Mountain sand,	300	225	525
Slate,	10	525	535
Sand,	20	535	555
Slate and shell,	25	555	580
Slate and shell,	10	580	590
Sand,	40	590	630
Red rock,	10	630	640
Slate,	30	640	670
Sand,	10	670	680
Slate,	30	680	710
Sand,	80	710	790
Slate and shells,	140	790	930
Sand,	30	930	960
Slate,	20	960	980
Murrysville sand (salt water),	50	980	1,030
Slate,	10	1,030	1,040
Sand,	30	1,040	1,070
Slate,	15	1,070	1,085
Hundred-foot sand (gas, 1,100 ft ,	55	1,085	1,140
Slate,	8	1,140	1,148
Sand,	55	1,148	1,203
Slate and shells,	59	1,203	1,262
Slate, shells and red rock,	183	1,262	1,445
Fourth sand,	25	1,445	1,470
Slate,	6	1,470	1,476

If the mouth of this well has the elevation given above, it is very probable that the 30 feet of sand from 1,040 form the top of the Hundred-foot, in which case this sand has the same elevation as in Well 137.

Record of Well 139, C. E. & W. S. Blair. Record furnished by the Apollo Gas Company, W. A. Louden, contractor. Elevation, 1,470.

	Thickness.	From.	To.
Clay,	27	0	27
Coal,	2	27	29
Clay,,	4	29	33
Slate,	67	33	100
Lime,	7	100	107
Slate,	190	107	297
Sand,	55	297	352
Slate,	10	352	362
Mountain sand,	83	362	445
Red rock,	5	445	450
Sand,	197	450	647
Slate,	3	647	650
Sand,	20	650	670
Slate and shells,	30	670	700
Red rock,	5	700	705
Sand,	80	705	785
Slate and shells,	206	785	991
Sand and shells,	46	991	1,037

Record of Well. C. E. & W. S. Blair—Continued.

	Thickness.	From.	To.
Murrysville sand,	47	1,037	1,084
Oil and salt water, 1,050 ft.			
Filled up with salt water, 1,064 ft.			
Slate,	10	1,084	1,094
Sand, salt water,	8	1,094	1,102
Slate and shells,	5	1,102	1,107
Slate,	18	1,107	1,125
Hundred-foot sand, gas at 1,140,	25	1,125	1,150
Slate,	32	1,150	1,182
Sand,	2	1,182	1,184
Slate,	18	1,184	1,202
Sand,	20	1,202	1,222
Slate and shells,	44	1,222	1,266
Sand,	56	1,266	1,322
Slate,	33	1,322	1,355
Sand,	18	1,355	1,373
Red rock,	43	1,373	1,416
Slate and shells,	119	1,416	1,535
Fourth sand,	30	1,535	1,565
Slate,	29	1,565	1,594
Drilled deeper:			
Slate,	3	1,594	1,597
Sand,	10	1,597	1,607
Red rock,	15	1,607	1,622
Slate and shells,	28	1,622	1,650
Black sand,	150	1,650	1,800
Slate and shell,	184	1,800	1,984
Red rock,	16	1,984	2,000
Slate and shell,	237	2,000	2,237
Sand,	15	2,237	2,252
Slate and shell,	125	2,252	2,377
Speechley sand,	30	2,377	2,407
Slate,	45	2,401	2,452
Sand,	45	2,452	2,497
Slate,	15	2,497	2,512

Record of Well 140, C. E. Blair No. 2. Record furnished by the Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,397

	Thickness.	From.	To.
Clay,	15	0	15
Soft slate,	35	15	50
Lime,	8	50	58
Slate,	42	58	100
Lime,	5	100	105
Sand,	35	105	140
Slate and shells,	65	140	205
Mountain sand,	250	205	455
Slate,	30	455	485
Sand,	98	485	583
Slate and shells,	39	583	622
Red rock,	8	622	630
Slate and shells,	40	630	670
Sand,	25	670	695
Slate and shells,	55	695	750
Sand,	40	750	790
Slate and shells,	140	790	930
Sand,	15	930	945
Slate,	12	945	957
Murrysville sand (salt water, gas and oil about 7 to 10 ft. in sand),	65	957	1,002
Slate,	23	1,002	1,045
Sand,	8	1,045	1,053
Slate,	10	1,053	1,063
Hundred-foot sand,	52	1,063	1,115
Slate,	5	1,115	1,120
Thirty-foot sand,	35	1,120	1,155
Slate,	15	1,155	1,170

Record of Well 140, C. E. Blair No. 2—Continued.

	Thickness.	From.	To.
Sand,	40	1,170	1,210
Slate,	5	1,210	1,215
Red rock,	28	1,215	1,243
Slate and shells,	215	1,243	1,458
Fourth sand,	59	1,458	1,517
Slate,	30	1,517	1,547
Red rock,	30	1,547	1,577
Slate,	33	1,577	1,610
Fifth sand,	5	1,610	1,615
Slate,	60	1,615	1,675

In the above records no mention is made of gas in the Speechley sand, and it is assumed that this sand is unproductive here. It will be noticed also that in 139 and 140 a show of oil with gas and salt water was found in the Murrysville sand. A similar condition was also found in the Murrysville sand of Well 141 which found this sand at 914 to 974 feet; the Hundred-foot from 1,025 to 1,077 feet; Thirty-foot at 1,081, 38 feet thick; 28 feet of Third at 1,398, and what is called the Fifth at 1,573 to 1,607 feet. This well has an elevation of 1,335 feet.

Record of Well 142, George Delp. Record furnished by the Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,480.

	Thickness.	From.	To.
Clay,	43	0	43
Slate,	57	43	100
Sand,	60	100	160
Limestone,	6	160	166
Slate,	54	166	220
Limestone,	5	220	225
Slate,	85	225	310
Coal,	3	310	313
Slate,	27	313	340
Sand,	40	340	380
Slate,	10	380	390
Sand,	25	390	415
Slate and shells,	115	415	530
Sand,	75	530	605
Slate,	10	605	615
Sand,	15	615	630
Slate and shells,	100	630	730
Red rock,	30	730	760
Slate and shells,	35	760	795
Red rock,	5	795	800
Sand,	10	800	810
Slate and shells,	20	810	830
Sand,	40	830	870
Slate and shells,	123	870	993
Hard shells,	17	993	1,010
Pebble sand,	5	1,010	1,015
Slate and shells,	17	1,015	1,032
Sand,	43	1,032	1,075
Slate,	95	1,075	1,170
Sand (gas at 1,175),	20	1,170	1,190
Slate,	25	1,190	1,215
Sand,	35	1,215	1,250
Slate and shells,	60	1,250	1,310

Record of Well 142, George Delp—Continued.

	Thickness.	From.	To.
Sand,	20	1,310	1,330
Slate,	20	1,330	1,350
Red rock,	30	1,350	1,380
Slate,	30	1,380	1,410
Third sand,	30	1,410	1,440
Slate and shells,	90	1,440	1,530
Fourth sand,	35	1,530	1,565
Slate and shells,	153	1,565	1,718

A section of this well is also shown on Plate II. In this section, the top of the Murrysville sand was considered to be the hard shells at 993, and the top of the Hundred-foot at 1,032 feet, the lower section of the latter sand being gas-bearing.

In the following record the same horizon is considered by the drillers to be the Thirty-foot sand, but the true Thirty-foot is probably included in the "slate and shells" below the two feet of red rock.

Record of Well 143. Henry Heller. Record furnished by the Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,432.

	Thickness.	From.	To.
Clay,	19	0	19
Slate,	21	19	40
Sand,	35	40	75
Slate and shells,	35	75	110
Limestone,	10	110	120
Slate,	46	120	166
Lime,	6	166	172
Slate,	63	172	235
Sand,	35	235	270
Coal,	4	270	274
Slate,	20	274	294
Mountain sand,	271	294	565
Slate,	5	565	570
Sand,	20	570	590
Slate,	180	590	770
Hard sand,	65	770	835
Slate,	50	835	885
Sand,	50	885	935
Slate,	30	935	965
Murraysville sand,	25	965	990
Slate,	10	990	1,000
Hundred-foot sand (a little salt water and oil),	47	1,000	1,047
Slate,	73	1,047	1,120
Thirty-foot sand (gas in top of sand),	35	1,120	1,155
Slate and shells,	40	1,155	1,195
Red rock,	2	1,195	1,197
Slate and shells,	48	1,197	1,245

Unfortunately no spirit levels were run to Well 144 on the G. R. Miller farm. The top of the Hundred-foot in this well it at a depth of 1.055 and the Murrysville at 946. These sands are here respectively 50 and 41 feet thick. The Murrysville sand contains a small amount of salt water in this well.

Record of Well 145, Eva Corbett. Record furnished by the Apollo Gas Co. Elevation, 1,520.

	Thickness.	From.	To.
Clay,	45	0	45
Slate,	90	45	135
Sand,	25	135	160
Slate,	97	160	257
Limestone,	6	257	263
Sand,	10	263	273
Slate,	37	273	310
Sand,	34	310	344
Slate,	25	344	369
Mountain sand,	256	369	625
Slate,	5	625	630
Sand,	40	630	670
Slate and shells,	158	670	828
Red rock,	5	828	833
Slate and shells,	42	833	875
Sand,	35	875	910
Slate,	74	910	984
Sand,	25	984	1,009
Slate and shells,	36	1,009	1,045
Murrysville sand (gas at 1,048),	22	1,045	1,067
Slate,	12	1,067	1,079
Sand,	54	1,079	1,133
Slate,	3	1,133	1,136
Hundred-foot sand (oil and sat water),	49	1,136	1,185
Slate,	5	1,185	1,190
Thirty-foot sand,	115	1,190	1,305
Slate,	33	1,305	1,338
Sand,	20	1,338	1,358
Slate and shells,	197	1,358	1,555
Fourth sand,	15	1,555	1,570
Slate and shells,	126	1,570	1,696

In this record, the top of the Hundred-foot sand is very probably at 1,078. The sand below the Thirty-foot at 1,338 is at the horizon of the Boulder.

No record of Well 146 on the James Blair farm is at hand. It has an elevation of 1,407 feet above sea-level.

Record of Well 147. Hervey Worneldorf. Record furnished by the Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,307.

	Thickness.	From.	To.
Clay and gravel,	26	0	26
Slate,	24	26	50
Sand,	80	50	130
Slate,	40	130	170
Sand,	50	170	220
Coal,	3	220	223
Slate,	10	223	233
Mountain sand,	210	233	443
Slate,	57	443	500
Sand,	25	500	525
Slate,	55	525	580
Red rock,	5	580	585
Slate and shells,	190	585	775
Murrysville sand (little gas),	29	775	804
Slate and shell,	116	804	920
Sand, Hundred-foot,	60	920	980
Red rock and shell,	110	980	1,090
Slate,	50	1,090	1,140

Record of Well 147. Henry Wornelsdorf—Continued.

	Thickness.	From.	To.
Red rock,	45	1,140	1,185
Slate,	10	1,185	1,195
Red rock,	20	1,195	1,215
Slate,	10	1,215	1,225
Third sand,	15	1,225	1,240
Red rock,	20	1,240	1,260
Fourth sand,	15	1,260	1,275
Slate,	10	1,275	1,285
Fifth sand,	20	1,285	1,305
Slate,	25	1,305	1,330

In Well 147 the Murrysville sand is correctly named, but the upper section of the Hundred-foot is here represented by "slate and shells." Assuming that the total thickness of this horizon is the same as in Well 145, the top of the Hundred-foot is here at a depth of about 844 feet.

The Piolett Gas Field.—This name is applied to the group of gas wells in the vicinity of the village of Piolett to the northeast.

The elevations of wells 148 and 149 on the James Blair and J. D. Henry farms, respectively, are 1,364 and 1,427 feet. These wells are gas producers in the Murrysville sand, at depths of 890 and 930 feet, respectively.

Well 150 on the C. A. Spindler farm got gas in the Murrysville sand and oil with salt water in the Hundred-foot, 25 feet from the top of the sand. The altitude of this well is 1,490 feet above the sea. In it the tops of the Murrysville and Hundred-foot sands are at depths of 980 and 1,022 feet respectively, showing an interval of 42 feet. Since the record of this well is the only one of wells in the group at Piolett, this interval is used here to get approximate distances to the top of the Hundred-foot from the Murrysville sand.

The top of Well 151 on the G. T. Henry farm has an elevation of 1,482 feet above sea-level. In this well the Murrysville sand, with gas, was found at a depth of 973 feet, and the top of the Hundred-foot sand is estimated to be about 1,015 feet.

Well 152 on the W. J. Daugherty farm having an elevation of 1,427 feet got the top of the Murrysville sand at 915 feet, with gas eight feet in the sand. This puts the top of the Hundred-foot sand (if the interval between it and the top of the Murrysville sand is the same as in 150) at about 957 feet, and the elevation of this sand above sea-level at about 470 feet.

Record of Well 153. Grant Phillips. Record furnished by Apollo Gas Company, W. A. Louden, contractor. Elevation, 1,307.

	Thickness.	From.	To.
Clay,	15	0	15
Ore and lime,	5	15	20
Fire clay,	5	20	25
Ore and lime,	7	25	32
Slate and shells,	78	32	110
Coal,	3	110	113
Slate and shells,	107	113	220
Mountain sand,	230	220	450
Slate,	30	450	480
Sand,	60	480	540
Slate,	14	540	554
Red rock,	5	554	559
Slate,	15	559	574
Red rock,	20	574	594
Slate,	20	594	614
Sand,	56	614	670
Slate and shells,	128	670	798
Sand,	77	798	875
Show of gas, Murrysville sand,	15	875	890
Slate,	44	890	934
Hundred-foot sand,	12	934	946
Slate,	56	946	1,002
Thirty-foot sand,	33	1,002	1,035
Red rock,	12	1,035	1,047
Slate and shells,	53	1,047	1,100
Sand (Fourth),	5	1,100	1,105
Slate,	46	1,105	1,151
Red rock,	33	1,151	1,184
Sand,	22	1,184	1,206
Slate, shells and red rock,	84	1,206	1,290
Sand,	25	1,290	1,315
Red rock,	13	1,315	1,328
Slate and shells,	16	1,328	1,344
Red rock,	17	1,344	1,361
Sand,	15	1,361	1,375
Slate and shells,	49	1,375	1,425
Red rock,	30	1,425	1,455
Slate and shells,	108	1,455	1,563
Red rock,	52	1,563	1,615
Slate and shells,	405	1,615	2,020
Sand,	56	2,020	2,076
Slate,	38	2,076	2,114
Sand,	6	2,114	2,120
Slate,	18	2,120	2,138
Slate and sand,	40	2,138	2,178
Speechley sand,	54	2,178	2,232
Gas at 2,237,	30	2,232	2,262
Slate and shells,	36	2,262	2,298
Tiona sand, gas at 2,310,	47	2,298	2,345
Slate and shells,	53	2,345	2,398
Sand,	6	2,398	2,404
Slate,	16	2,404	2,420
Black sand,	15	2,420	2,435
Slate,	28	2,435	2,463

Since Well 153 had a strategic structural position, it is very important that a correct correlation of the sands in it be made. It is possible that the Murrysville sand is incorrectly named in this record. This horizon may really be the upper portion of the sand at 797. A plotted section of this record when compared with the average section plate and with Well 158 shows the evidence to be about equally divided on this point. The 12 feet of sand at 934 is at the horizon of the lower section of the Hundred-foot sand. Also as the record stands the distance from the bottom of the Big Injun to the top of the Murrysville is somewhat above the average and greater than that of other wells in this vicinity. On the strength of all the available stratigraphic evidence, the writer is inclined to consider the sand at 875 to be at or near the top of the Hundred-foot horizon. The elevation of the top of the Hundred-foot here is therefore considered to be about 432 feet above sea-level.

No record of the Milton Hepler No. 1 Well (No. 154) is at hand. The top of the casing in this well has an elevation of 1,292 feet.

No. 2 on this farm (No. 155) has an elevation of 1,324. In this well the top of the Murrysville sand is at 821 feet, the bottom of the hole being 843 feet below. The top of the Hundred-foot is here estimated to be at a depth of about 861 feet, or 463 feet above sea-level.

The Miller Hepler No. 3 Well (No. 156) has an elevation of 1,310 feet. No record of it was secured.

Record of Well 157. Wm. Sheridan. Record furnished by the Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,421.

	Thickness.	From.	To.
Clay,	28	0	28
Slate and shells,	72	28	100
Lime,	6	100	106
Slate,	154	106	260
Mountain sand,	289	260	549
Lime and sand,	31	549	580
Slate,	30	580	610
Sand,	55	610	665
Red rock,	10	665	675
Sand,	100	675	775
Slate,	133	775	908
Murrysville sand,	15	908	923
Slate,	23	923	946
Hundred-foot sand,	15	946	961
Slate,	46	961	1,007
Sand,	8	1,007	1,015
Slate,	23	1,015	1,038
Sand, Thirty-foot,	22	1,038	1,060
Slate and shells,	379	1,060	1,439
Fifth sand,	15	1,439	1,454
Slate and shells,	846	1,454	2,300
Speechley sand (little gas),	25	2,300	2,325
Slate and shell,	269	2,325	2,594
Brown sand,	50	2,594	2,644
Slate,	42	2,644	2,686
Brown sand (little salt water),	20	2,686	2,706
Gray sand,	120	2,706	2,826
Brown sand,	10	2,826	2,836
Gray sand,	56	2,836	2,892
Slate,	38	2,892	2,930

Well 158 is recorded as being on the farm of the G. T. Henry Heirs and at an elevation of 1,324 feet, but the farm number of this well is not given. A record of the G. T. Henry Heirs Company No. 199 by the Apollo Gas Co., gives the top of the Murrysville sand, with gas, at 973 feet. The record is evidently not of Well 158 as this would give the Hundred-foot sand here an elevation of only 313 feet above sea-level, when it is very probably about 480 feet.

In the northeast portion of Porter township little drilling has been done. In the course of the field work for this paper only three wells were located in this area. Of these one is a hole (No. 159), of which nothing is known, situated about half a mile northeast of Jacks schoolhouse.

Well 160 is an old hole on the A. A. Brinker farm of which nothing is known except that it showed some gas, and has an elevation of 1,344 feet.

Record of Well 161. A. A. Brinker. Record furnished by the Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,407.

	Thickness.	From.	To.
Clay and gravel,	29	0	29
Sand,	40	29	69
Broken sand,	151	69	220
Slate,	20	220	240
Mountain sand,	258	240	498
Slate,	37	498	535
Red rock,	5	535	540
Slate,	45	540	585
Sand,	25	585	610
Slate and shells,	130	610	740
Murrysville sand (gas),	22	740	762
Slate,	25	762	787
Hundred-foot sand,	84	787	871
Slate,	69	871	940
Thirty-foot sand,	20	940	960
Red sand,	22	960	982
Gray sand,	12	982	994
Slate,	71	994	1,065
Red rock,	35	1,065	1,100
Slate and shells,	20	1,100	1,120
Red rock,	132	1,120	1,252
Sand,	8	1,252	1,260
Slate,	97	1,260	1,357
Red rock,	20	1,357	1,377
Slate and shells,	735	1,377	2,112
Speechley sand,	48	2,112	2,160
Slate,	80	2,160	2,240
Tiona sand,	12	2,240	2,252
Slate,	194	2,252	2,446
Bradford sand (gas in top of sand),	100	2,446	2,546
Slate,	30	2,546	2,576

The section of Well 161 is given on Plate II.

Well 162 on what was formerly the Thomas Slaughenhaupt farm has an elevation of 1,381 feet. In it the top of the Murrysville, Hundred-foot, Fourth, Speechley and Tiona sands are at depths of 835, 855, 1,355, 2,220 and 2,400 feet respectively. Shows of gas were found in the Murrysville and Speechley, with salt water in the Hundred-foot, 35 feet from the top of that sand.

Record of Well 163. J. B. Slaughenhaupt. Record furnished by the Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,435.

	Thickness.	From.	To.
Clay and gravel,	40	0	40
Slate,	50	40	90
Sand,	30	90	120
Slate,	8	120	128
Mountain sand,	192	128	320
Slate,	15	320	335
Sand,	185	335	520
Red rock,	5	520	525
Slate and shells,	70	525	595
Sand,	35	595	630
Slate and shells,	15	630	645
Sand,	10	645	655
Slate and shells,	145	655	800
Sand,	5	800	805
Slate and shells,	40	805	845
Murrysville sand (gas and salt water),	60	845	905
Slate,	10	905	915
Sand (a little gas),	35	915	950
Slate and shell,	20	950	970
Sand,	30	970	1,000
Slate and shells,	40	1,000	1,040
Sand,	8	1,040	1,048
Slate and shells,	52	1,048	1,100
Sand,	10	1,100	1,110
Red rock,	50	1,110	1,160
Slate and shells,	15	1,160	1,175
Sand (salt water),	10	1,175	1,185
Red rock,	35	1,185	1,220
Slate,	5	1,220	1,225
Red rock,	35	1,225	1,260
Slate,	5	1,260	1,265
Fourth sand,	25	1,265	1,290
Red rock,	27	1,290	1,317
Slate,	5	1,317	1,322
Fifth sand,	40	1,322	1,362
Slate,	38	1,362	1,400
Red rock,	5	1,400	1,405
Slate,	50	1,405	1,455
Red rock,	8	1,455	1,463
Slate,	17	1,463	1,480
Sand,	5	1,480	1,485
Slate,	40	1,485	1,525
Black sand,	45	1,525	1,570
Slate and shell,	211	1,570	1,781
Red rock,	20	1,781	1,801
Slate and shell,	294	1,801	2,095
Sand,	15	2,095	2,110
Slate,	70	2,110	2,180
Speechley sand (gas),	30	2,180	2,210
Slate and shells,	122	2,210	2,332

In the above record of Well 163, the Murrysville sand is believed to be represented by the five-foot sand at 800 feet, the lower part of the horizon being occupied by "slate and shells." It is possible that the top portion of the sand at 845 is the Murrysville, but this is belived to be the Hundred-foot. A comparison of the plotted records of surrounding wells with this one strengthens this conclusion. It will be noticed that the sand at 1,175 (Thirty-foot) carries salt water in this well.

Bittenbender Gas Field.—A few wells on the northern edge of this field lie in Monroe township and have been discussed under that township. Southwest from those wells, the field crosses the northwestern part of Porter township as a narrow belt and extends some distance into Toby township on the west. The principal gas sand of this field is the Murrysville; the Hundred-foot, Speechley and Bradford sands have also produced more or less gas. While this cannot be classed as a large field in point of amount of gas produced, it is still one of considerable local importance.

Well 164 on the Philip Bittenbender got gas in the Murrysville and Hundred-foot sands. The top of the latter is at a depth of 781 feet. The Speechley, Tiona and Bradford sands are given at depths of 2,095, 2,237 and 2,478 feet respectively from the top of the well, which has an altitude of 1,327 feet above tide.

Wells 165, 166 and 167 on the Bittenbender farm are respectively at elevations of 1,337, 1,279 and 1,295 feet. In 165 the Murrysville and Hundred-foot sands are at depths of 758 and 788 feet respectively. Most of the gas comes from the Murysville in this well; the Hundred-foot also carries some salt water. No record of 166 was secured.

Well 167 was drilled only through the Murrysville sand which was found with gas at 708 feet. The Hundred-foot in this well is estimated to be at a depth of 738 feet, or 537 feet above sea-level. Well 168 has an elevation of 1,289 feet, no record of which is available.

Well 169 on the Bittenbender farm has an elevation of 1,284 feet. Gas was found in the Murrysville sand at a depth of 722 feet.

Below is a typical record of wells on this farm:

Record of Well 170. Jacob Bittenbender, Alice Longwell. Record furnished by the Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,310.

	Thickness.	From.	To.
Gravel,	30	0	30
Sand,	55	30	85
Slate,	15	85	100
Sand,	8	100	108
Slate,	27	108	135
Mountain sand,	190	135	325
Slate,	5	325	330
Sand,	40	330	370
Slate,	6	370	376
Sand,	10	376	386
Slate,	22	386	408
Red rock,	5	408	413
Slate,	5	413	418
Sand, salt water,	27	418	445
Slate,	20	445	465
Sand (a little gas at 486 and 503),	105	465	570
Slate and shell,	135	570	705
Murrysville sand (gas),	17	705	722
Slate,	12	722	734
Slate,	9	734	743
Hundred-foot sand,	30	743	773
Slate,	227	773	1,000
Red rock,	15	1,000	1,015
Slate and shells,	78	1,015	1,093
Sand,	8	1,093	1,101
Slate,	74	1,101	1,175
Fourth sand,	48	1,175	1,223
Slate and shells,	57	1,223	1,280

Record of Well 170. Jacob Bittenbender, Alice Longwell—Continued.

	Thickness.	From.	To.
Red rock,	25	1,280	1,305
Slate and shells,	770	1,305	2,075
Speechley sand (gas 3 ft. in sand),	38	2,075	2,113
Slate and shells,	274	2,113	2,387
Bradford sand (little gas),	20	2,387	2,407
Slate,	37	2,407	2,444
Sand,	63	2,444	2,507
Slate.	34	2,507	2,541

Wells 171 and 172 on the Wm. Ham and Henry Summerville farms, respectively, have elevations of 1,300 and 1,362 feet. No records of these wells were secured. Wells 173 and 174, on the Hoover Heirs and W. C. Bayers farms, respectively, have elevations of 1,421 and 1,402 feet. These wells found the Murrysville sand at 861 and 815 feet, respectively, with thicknesses of 17 and 34 feet. Both wells produce gas from this sand.

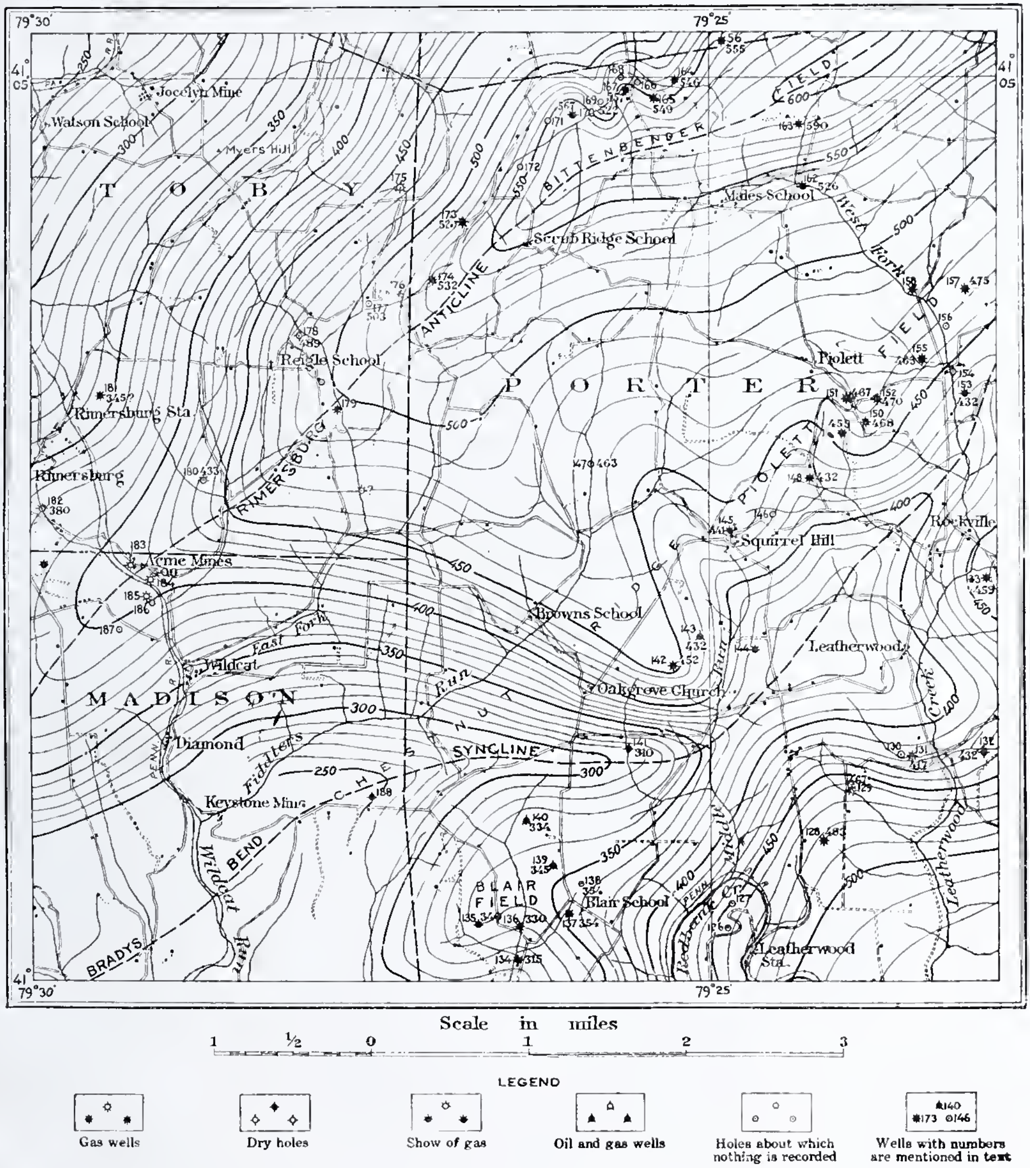
Structure.—The Kellersburg and Rimersburg anticlines and the Brady's Bend syncline, are the principal structural features of the Porter township. The axes of these folds normally pitch to the south, but in the central and southern part of the township the uniform pitch of the Kellersburg and the Brady's Bend folds is broken by indistinct cross-folds having a general northwest-southeast trend. In the Kellersburg anticline, which enters the quadrangle from the south, about one mile east of Leatherwood station, and leaves the township near the northeast corner, the axis pitches from both directions towards a point about one-fourth mile north of southern edge of the quadrangle. The cross syncline which forms this depression is traceable in a north western direction to a point about two miles northwest of Squirrel Hill. This deformation is responsible for a small basin in the trough of the Brady's Bend syncline, which it crosses almost at right angles, and affected the shape of the Reidsburg syncline in the vicinity of Sligo.

Almost one mile south of this cross-trough, the corresponding cross-arch forms a long anticlinal nose to the southeast from the crest of the Rimersburg anticline at the point where it crosses the western boundary of the township.

Southward from the point where this secondary arch crosses the Brady's Bend syncline, the axis of the latter bends abruptly to the west, pitching rapidly to the western edge of the township. This cross-arch also forms a small dome on the crest of the Kellersburg anticline at the southern edge of the quadrangle.

Possible Location of Undeveloped Pools.—There are few indications to induce drilling for oil in Porter township, but from the data in hand, there are good reasons for believing that considerable gas

PLATE IX



Contours on top of 100-foot sand Contour interval 10 feet Datum is mean sea level

territory still remains to be developed. Most of this favorable territory lies along the crests of the Kellersburg and Rimersburg anticlines at points where good pay streaks have been shown to exist in the Murysville Hundred-foot, Fourth and Speechley sands. On the former fold it is thought that the Bradford and Tiona sands also have a fair chance of being gas-bearing.

On Plate IX. it will be seen that contours drawn on the top of the Hundred-foot sand show a broad, flat terrace-like slope on the east side of the Rimersburg anticline from a mile south of Reigle schoolhouse in the eastern part of Toby township to Well No. 142. To the northeast from this well the lower edge of the terrace is marked by the 450-foot contour. Above this contour and between it and the axis of the Rimersburg anticline, there is a good chance of getting moderate gas wells in some one of the well-developed sands, from the Murrysville down to and including the Speechley.

The above records give a fair idea of the condition of the pay in each of these sands. From the map it can be seen that the more favorable locations for gas in this area are along the crests of the minor cross-arches that traverse the terrace in a northwest-southeast direction. For this reason the writer suggests that the small arch running from a point three quarters of a mile east of Reigle schoolhouse, southeast to Well No. 142, offers a fair chance for the development of one or more gas pools. A good location for a test well would be on Fiddlers Run, half a mile northeast of Brown's school. Another good location is from one-half to one mile north of Squirrel Hill.

There is no evidence for the belief that much oil will be found in Porter township. The best location for a test for oil in the Murrysville and Hundred-foot sands, is on Fiddlers Run at the fork roads one-half mile northwest of Squirrel Hill (Plate IX). If oil is found here it will be a comparatively small pool, which should be cautiously extended southward. If gas and a show of oil without salt water is found in either the Hundred-foot or Murrysville sands at this point, the best test for oil in paying quantities will be two locations due south. If a show of oil with salt water is found in the first well, the next location should be on Fiddlers Run, 2,000 feet to the southwest.

There is also a chance of finding a small pool of oil in the Murrysville sand half a mile or more due east of the C. E. Blair No. 2 Well (No. 140), at a point where the 350-foot contour (Plate IX.) crosses the road leading northeast from Blairs' schoolhouse. If oil in paying quantities should be found here, the structure contours of Plate IX. should be closely followed in making extensions. If much salt water accompanies the oil, locations should be made to the east somewhat further up the slope of the sand. If little or no water accompanies the oil, the producer can afford to cautiously extend the development westward. Oil wells in this area will flow, and the life of the wells will doubtless be comparatively short. If a fair size pool of oil should be developed in either of the locations mentioned above, a test about one-third of a mile southwest of Leatherwood would have a fair show of getting oil in the same sand. If the above locations should prove unproductive, the chances for finding oil in Porter township do not justify further prospecting at the present time.

TOBY TOWNSHIP, CLARION COUNTY.

Toby township lies west of Porter and south of Piney townships. Only the eastern portion of this area lies within the Clarion quadrangle. No holes have been drilled in this portion of the township, except in the southeastern half. The productive portion is confined to a few wells along the southwestern extension of the Bittenbender gas field.

Gas Well No. 175 on the McCall farm has an elevation of 1,346. No record of this well could be secured.

On the C. A. Kellar farm, Well 176, having an elevation of 1,387, found the top of the Murrysville sand, with gas, at a depth of 815 feet. The exact distance from the top of the Murrysville to the top of the Hundred-foot in this area is hard to determine, because of the thinness and variability of the latter. In Well 170 the distance is 38 feet; in Well 178 it is probably 62 feet; in Well 176 this distance is probably about 54 feet.

In Well 177 on the Aaron Kline farm, the top of the Murrysville was found at a depth of 796 feet, the mouth of the well being at an altitude of 1,355 feet. In this well the top of the Hundred-foot sand is supposed to be 56 feet below the top of the Murrysville, or at an elevation of 503 feet above sea-level. No mention is made in the record of what this well produced.

Record of Well 178. Jos. Downs (now Tom George). Record furnished by the Apollo Gas Co., W. A. Louden, contractor.
Elevation, 1,337.

	Thickness.	From.	To.
Mud,	6	0	6
Sand,	10	6	16
Slate,	14	16	30
Sand,	160	30	190
Slate,	22	190	212
Mountain sand,	273	212	485
Red rock,	5	485	490
Slate,	91	490	581
Sand,	69	581	650
Slate and shell,	136	650	786

Record of Well 178. Jos. Downs (now Tom George)—Continued.

	Thickness.	From.	To.
Murraysville sand (a little gas),	11	786	797
Slate,	28	797	825
Red rock,	23	825	848
Hundred-foot sand,	20	848	868
Slate and shell,	87	868	955
Thirty-foot sand,	18	955	973
Slate,	9	973	982
Red rock,	5	982	987
Slate and shells,	257	987	1,244
Fourth sand (some gas at 1,252 ft),	20	1,244	1,264
Slate and shells,	95	1,264	1,359
Fifth sand,	15	1,359	1,374
Slate,	8	1,374	1,382

In this well it will be noticed that 23 feet of red rock occupy a portion of the interval between the Murrysville and Hundred-foot sands. A section of this well is shown on Plate III.

Nothing is known of the three wells to the southeast of No. 178, except that one of them, it is said, presumably No. 179, on the Jonah Flick farm, developed sufficient gas to blow the casing out. All of these holes are old, and little accurate information could be secured regarding them.

Report of Well 180. Will Stephens. Record furnished by Apollo Gas Co., W. A. Louden, contractor. Elevation, 1,315.

	Thickness.	From.	To.
Mud,	20	0	20
Slate,	60	20	80
Sand,	120	80	200
Slate,	25	200	225
Mountain sand,	175	225	400
Slate,	5	400	405
Sand,	20	405	425
Slate and shell,	40	425	465
Sand,	10	465	475
Slate and shell,	105	475	580
Sand,	60	580	640
Slate,	180	640	820
Murrysville sand (a little gas),	10	820	830
Slate,	5	830	835
Red rock,	5	835	840
Slate and shells,	85	840	925
Hundred-foot sand,	15	925	940
Slate and shells,	35	940	975
Red rock,	5	975	980
Slate,	10	980	990
Thirty-foot sand,	20	990	1,010
Slate,	24	1,010	1,034
Red rock,	12	1,034	1,046
Slate,	16	1,046	1,062
Sand,	20	1,062	1,082
Red rock,	15	1,082	1,097
Sand,	48	1,097	1,145
Sand (a little gas),	20	1,145	1,165
Slate,	35	1,165	1,200
Red rock,	40	1,200	1,240
Slate and shell,	120	1,240	1,360
Red rock,	8	1,360	1,368
Slate and shell,	135	1,368	1,503
Red rock,	15	1,503	1,518
Slate,	19	1,518	1,537

In Well 180 it will be noticed that the red rock between the Murrysville and Hundred-foot sands mentioned in Well 178 is also found here. It is considered that the top of the Hundred-foot sand is somewhere in the 85 feet of "slate and shells" below this red rock. It is considered as approximately the same as in Well 178, but this estimate may be in considerable error. The sand showing a little gas at 1,145 is doubtless the Third sand as may be seen by an examination of the section of this well, Plate III.

Well 181, (Eckels No. 1) got what is said to be the Murrysville sand with gas at a depth of 949 feet. This well has an elevation of 1,356 feet. If the Hundred-foot sand be considered at the same distance (62 feet) below the Murrysville, as in 178 and 181, it is here at an elevation of 345 feet above sea-level. The gas in this well had a closed pressure of 250 pounds, but the gas was exhausted after a few weeks. The well was then drilled deeper without finding new production.

The following record is all that could be found of Well 182:

Record of Well 182. Stewart Well. Record furnished by Pennsylvania Fuel Supply Co. Elevation, 1,426.

	Thickness.	From.	To.
Coal,		135	
Limestone,		180	
Coal,		232	
Sixty-foot sand,	35	327	362
Slate,	12	362	374
Mountain sand, ?	10	374	384
Slate,	26	384	410
Slate,	30	410	440
Mountain sand:			
Red sand,	10	440	450
Slate,	20	450	470
Sand,	110	470	580
Slate,	6	580	586
Cased at,		592	
Slate,	14	695	
Sand,	18		
Salt water,		727	
Slate and shale,	13	727	740
Sand,	30	740	770
Slate,	30	770	800
Sand (gas, light),	16	800	816
Slate,	168	816	984
Sand (gas),	7	984	991
Slate and shale,	59	991	1,050
Bottom. Light gas well.			

This record is so incomplete that positive identification of beds from it is impossible. Since no accurate data are available, it is assumed that the sand at 987 is the Murrysville, and that the top of the Hundred-foot horizon lies 62 feet below at a depth of 1,046 feet.

Structure.—The Rimersburg anticline crosses the southeast corner of the township, and it is thought that the bottom of the Reidsburg syncline crosses the northwest corner of that portion of the township embraced by the Clarion quadrangle. There is some question as to the location of the axis of the Rimersburg anticline in the vicinity of that village, and it is possible that the axis of this fold leaves the quadrangle near the southern edge of the township instead of in Madison township, as shown on Plate IX.

The structure of the Hundred-foot sand north of the axis of the Rimersburg anticline has not been determined, and the contours of Plate IX. are at best only approximately correct.

MADISON TOWNSHIP, CLARION COUNTY.

A small portion of Madison township is embraced in the southwest corner of Clarion quadrangle.

So far as the writer could learn, less than a dozen deep holes have been drilled within this area. The records of these are very poor, in most cases nothing of stratigraphic value being found except the depth of the producing sand.

In the group of gas wells about one miles southeast of Rimersburg, Well 183 on the Walters farm (No. 1), with an elevation of 1,231 feet got gas in what is called the Fourth sand at a depth of 1,230 feet.

Well 184, on the same farm (No. 2), got gas in the Fourth at 1,178 to 1,198 feet. The elevation of this well is 1,212 feet; closed pressure of the gas, 400 pounds.

On the same farm, Well 185 found gas at 1,053 feet, and also the Fourth sand at 1,296 to 1,322 feet with gas at 1,304 feet. The closed pressure was 80 pounds. This well has an elevation of 1,306 feet above sea-level.

In these wells it is difficult to calculate the elevation of the top of the Hundred-foot horizon because the sand is probably represented only by a mass of "slate and shells." The best that can be done by such calculation is to get the approximate elevation of the top of the Hundred-foot in this group of wells. It is estimated to be here about 400 feet above tide.

About one and a half miles south of Rimersburg, a well on the J. H. Abrams farm and another on the W. H. Craig property are located a short distance off the Clarion quadrangle. The records of these wells are given below.

Record of J. H. Abams No. 2 Well. Record furnished by the Pennsylvania Fuel Supply Co. Elevation, 1,222.

	Thickness.	From.	To.
First sand (little gas),		505	560
Murrysville,		781	789
Hundred-foot,		1,000	1,100
Fourth sand,		1,275	
Gas,		1,280	
			1,287

"O. K. Record."

Record of W. H. Craig No. 1 Well. Record furnished by the Pennsylvania Fuel Supply Co. Elevation, 1,153.

	Thickness.	From.	To.
Mountain sand,		170	380
First sand, top,		480	
Murrysville,		740	

"O. K. Record."

In these records the Murrysville sand is assumed to be correctly named, and the top of the Hundred-foot is supposed to be about 62 feet below.

Well 188, on the S. G. Sloan farm, has an elevation of approximately 1,476 feet. No record of this well could be found, which is to be regretter since it occupies a strategic position near the axis of the Brady's Bend syncline.

Structure.—The axis of the Rimersburg syncline crosses the northwest corner of the area, and that of the Brady's Bend syncline passes through the southern part, both having a northeast-southwest trend, with axes pitching rapidly to the southwest. Few details of structure in the Hundred-foot sand of this township were determined, and the contours drawn on this sand over much of the area are doubtless more or less in error. The Abram and Craig records given above fix fairly accurately, however, the location of the contours along the western margin of the quadrangle.

Favorable Locations for Gas Pools in Toby and Madison Townships.—Most of the gas yet to be found in these townships will doubtless be discovered to be along the crest and well up the flanks of the Rimersburg anticline, but owing to the limited amount of information available regarding the condition of the sands in this area, no suggestions of value to producers can be made.

LIST OF WELLS ON THE CLARION QUADRANGLE.

Name of Farm.	Name of Company.	Elevation of Mouth.
Amsler, A. E., No. 1,	People's Natural Gas Co.,	1,515-*10
Barlett, D. F., No. 1,	Phillips Oil and Gas Co.,	1,350 (?)
Beaver Property, No. 1,	Standard Oil Co.,	1,116
Benner, Mrs. J. B.,	Clarion Gas Co.,	1,405-*5
Bish, William,	Oil City Fuel Supply Co.,	1,450
Bittenbender, No. 141,	Apollo Gas Co.,	1,279
Blair, James,	Apollo Gas Co.,	1.407
Brinker, A. A.,	Carnegie Gas Co.,	1,344
Brinnaman, Wm.,	Wm. Brinnaman,	1,441 (?)
Brisben Heirs, No. 1,	Beatty Oil Co.,	1,456
Puffington, R.,	People's Gas Co.,	1,395 (?)
Buffington, R.,	People's Gas Co.,	1,411
Campbell, John,	Apollo Gas Co.,	1,526
Campbell, No. 2,	Canton Tile Co.,	1,229
(16) Carnahan, L. S.,	?	1,317
Conner, S. J.,	People's Co.,	1,612 (?)
Cooper, J. A.,	Culberson, Oliver,	1,455
Cooper, W. H.,	McKeifer, Contractor,	1,325
Craig, Chas., No. 2,	Sligo Oil & Gas Co.,	1,268
Craig, Chas., No. 3,	Sligo Oil & Gas Co.,	1,224
Craig, Harrison,	Phillips Oil & Gas Co.,	1,384
Craig, Mrs. Joe,	A. W. Craig, Limestone, Pa.,	1,355
Craig, W. T.,	A. A. Stewart,	1,278
Craig, W. T., & Son,	W. T. Craig & Son,	1,271
Crooke, Wm.,	Apollo Gas Co.,	1,463
(201) ?	Oliver Culberson,	1.440
Dougherty,	Pennsylvania Fuel Supply Co.,	1,447
Dougherty Heirs,	Climax Firebrick Co.,	1,423
Dougherty, J. P., No. 1,	Apollo Gas Co.,	1,585-*10
Mallet, Jos., No. 1,		1,587-*12
Eberline, John,	Home Oil and Gas Co.,	1,260
Eberline, John,	Home Oil and Gas Co.,	1.308
Fiddler, No. 1,	Newland Oil Co.,	1,500-*10
	Probably about	1.497
Fox, P. M.,	T. W. Phelps Co.,	1,234
Frampton, T. W.,	Monroe Oil Co.,	1,250
Frinnefrock, Dan., No. 2,	Phillips Oil and Gas Co.,	1,401
Frinnefrock, Dan., No. 3,	Phillips Oil and Gas Co.,	1,397
Frinnefrock, John, No. 2,	Phillips Co.,	1.420
Fulton, Jennie, No. 1,	Philips Oil and Gas Co.,	(?)1,265-*5
George, Joseph, No. 5,	Huling (Clarion) Contractor,	1,408
Greyer,	Dexter Gas Co.,	1.187
Gross, John,	Clarion Gas Co.,	1,408
Hahn, No. 2,	John Collett,	1,238
Ham, Jos.,	Phillips Co.,	1,426
Ham, Will,	Apollo Gas Co.,	1.300
Hanst, J. E., No. 3,	No record,	1,277
Hepler, Frank,	John A. Magee (deceased),	1.417
Hepler, Milton, No. 1,	Carnegie Gas Co.,	1,292
Hepler, Milton, No. 3,	Apollo Gas Co.,	1,310
Hessin, No. 1,	Dexter Gas Co.,	1.042
Hessin, No. 2,	Dexter Gas Co.,	1.053
Howard, John,	Phillips Co.,	1,272
Imhoff, Isaac, No. 1,	Carnegie Gas Co.,	1,525
Keller,	Apollo Gas Co.,	1.460
Kiser, S. E.,	S. E. Kiser,	1,430
Kiser, S. E.,	S. E. Kiser,	1.451
Klingensmith, T. A.,	Phillips Co.,	1.405
Lankard, S.,	Pennsylvania Fuel Supply Co.,	1,420
Lankard, Sam, No. 1,	Pennsylvania Fuel Supply Co.,	1,529
Lankard, Sam, No. 2,	Pennsylvania Fuel Supply Co.,	1,490
Lankard, W. H.,	Pennsylvania Fuel Supply Co.,	1,285
Lankard, W. H.,	Pennsylvania Fuel Supply Co.,	1,293
Lerch, A. B.,	Emlenton Co.,	1.317
Lintz, F. M., No. 4, ?	Culberson,	1,315
Longwell, Elmer, No. 13,	Apollo Gas Co.,	1,295 (?)
Longwell, Elmer, No. 140,	Apollo Gas Co.,	1,289
Longwell, Elmer, No. 139,	Apollo Gas Co.,	1,310
Lyntz, Wm.,	Oliver Culberson,	1.355
Madison,	Old well cleaned out,	1,004
Mahk, Sam., No. 1,	Clarion Gas Co.,	1,533
Mahk, Sam., No. 3,	Clarion Gas Co.,	1,536
McCabe, Mary,	Home Gas Co.,	1,515-*4
McCall, Chalmer,	Emlenton Gas Co.,	1,346
McClain, Wm., No. 1,	Home Gas Co.,	1,500
McEwen, F. C., No. 1,	A. W. Feely,	1,295-*10
McEwen, F. C., No. 1,	Phillips Oil and Gas Co.,	1,295
McLane, Frank, No. 2,	Home Gas Co.,	1,447

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*The probable error is within the number of feet indicated by the figure at the right of the elevation given.

LIST OF WELLS ON THE CLARION QUADRANGLE—Continued.

Name of Farm.	Name of Company.	Elevation of Mouth.
McLane, George, No. 1,	Home Gas Co.,	1,400
Miller, J. B., No. 2,	J. D. Miller,	1,145
Miller, J. B., No. 3,	J. B. Miller,	1,146
Miller, John,	Pennsylvania Fuel Supply Co.,	1,259
Miller, Valentine,	Pennsylvania Fuel Supply Co.,	1,278
Mires, McLaughlin & Lutz, No. 1,	Oliver Culberson,	1,365
Mires, McLaughlin & Lutz, No. 2,	Oliver Culberson,	1,341 (?)
Molmey, Warren,	?	1,238
Moss, John, No. 1,	Oliver Culberson,	1,436
Moyer, John, No. 1,	People's Natural Gas Co.,	1,540 (?)
Myers, Mrs. Jim,	T. W. Phillips,	1,196
Pence, Irwin,	Dexter Gas Co.,	1,298
Potter, Clark, No. 1,	Clarion Gas Co.,	1,364–*3
Potter Heirs,	Apollo Gas Co.,	1,592
Rankin, C. A.,	Clarion Gas Co.,	1,414–*3
Reed & Bacody, No. 1,	Home Gas Co., (?)	1,510
Reed, W. L., No. 1, (?)	Pittsburg Oil and Gas Co.,	1,476
Reynolds, J. H.,	Town Run Oil and Gas Co.,	1,402
Rhodes, L.,	Town Run Oil and Gas Co.,	1,335
(224) Shannon, P. M., No. 1,	Rock Oil and Gas Co., (?)	1,303
Shick, John,	Howthorn Pottery Co.,	1,165
Shirey, J. B., No. 3,	Pennsylvania Fuel Supply Co.,	1,530
Simpson, Joe,	Hulings Co.,	1,510
Sligo, No. 1,	Sligo Oil and Gas Co.,	1,157
Sloan,	Oliver Culberson,	1,453
Sloan, S. G., No. 1,	Apollo Gas Co.,	1,476–*5
Smathers, Widow,	Clarion Co.,	1,503
Snow,	Standard Oil Co.,	1,284
Snyder, Amos,	Phillips Co.,	1,370
Steltzer, Christina,	Pennsylvania Fuel Supply Co.,	1,309
Steltzer, J. M.,	Pennsylvania Fuel Supply Co.,	1,368
Stewart, Allen,	T. W. Phillips,	1,259
Stewart, Allen, No. 2,	Sligo Oil and Gas Co.,	1,244
Stewart, James,	Apollo Gas Co.,	1,320
Stratton, H. F.,	Clarion Co.,	1,459
Summerville, Dr.,	Pennsylvania Fuel Supply Co.,	1,375
Summerville, Henry,	Apollo Gas Co.,	1,362
Thompson, P. H.,	P. H. Thompson,	1,535
Thompson, P. H., No. 1,	Clarion Gas Co.,	1,535–*2
Wheelock, "Sheriff," No. 2,	Clarion Gas Co.,	1,437
Walters, Mrs. Elizabeth,	Oliver Culberson,	1,336
White, William,	Pennsylvania Fuel Supply Co.,	1,430
White, William,	Pennsylvania Fuel Supply Co.,	1,628
White, W. M., ?	Pennsylvania Fuel Supply Co.,	1,628
Wiant, No. 1,	Climax Clarion Co.,	1,161
Wiant, W. M., No. 2,	Climax Firebrick Co.,	968
Williams, Nora & May, No. 1,	Home Gas Co.,	1,419
Winkler, John,	Phillips Co.,	1,102

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*The probable error is within the number of feet indicated by the figure at the right of the elevation given.

INDEX.

A.

Page.
Abrams, J. H., Well, record of, 104
Allegheny Formation, 20
Anticline, Kellersburg, 29
  Miola, 30
  Rimersburg, 29

B.

Barber, Well No. 1, record of, 49
Bashline, Well No. 1, record of, 55
Beal, Samuel, Well No. 1, record of, 36
Beatty, David, Well No. 18, record of, 81
Beaver Township, 34
Bittenbender, Gas Pool, 96
  Jacob-Alice Longwell,
    Well, record of, 97
Blair, Calvin, Well No. 1, record of, 85
    Well No. 2, record of, 84
    Well No. 3, record of, 87
  C. E., Well No. 2, record of, 88
  C. E. & W. S., Well, record of, 87
  Gas Field, 84
Blyson Run Well, record of, 44
Bodenhorn, M. T., Well, record of, 73
Bradys Bend Syncline, 30
Brinker, A. A., Well, record of, 95
  Jacob, well, No. 1, record of, 75
Brookville, Coal, 21-24
Buffington, Orr, Well, record of, 67

C.

Carboniferous System, 18
Catskill Formation, 16
Chemung Formation, 16
Clarion coals, 21-24
  Oil pool, 45-51
  Syncline, 30
  Township, 45
Clay, Lower Kittanning, 25
  Upper Freeport Flint, 23
Coal, Brookville, 21-24
  Clarion, 21-24
  Lower Freeport, 23
    Kittanning, 22-25
  Middle Kittanning, 23-26
  Mahoning, 26
  Upper Freeport, 23
    Kittanning, 23-26
Conemaugh formation, 26
Conner, D., Well No. 1, record of, 52
Connoquenessing Sandstone, 20
Convergence, between Lower Kittanning coal and Hundred-foot sand, 29
Corbett, Eva, Well, record of, 91
Craig, W. H., Well, record of, 104

D.

Delp, Geo., Well, record of, 89
Devonian System, 16
Ditty, Scott B., Well No. 1, record of, 75
Downs, Jos., Well, record of, 100

E.

Page.

- Elk City Pool, 31
- Elk Township, 30

F.

- Fairmount Syncline, 29
- Furgeson, B. B., Well No. 1, record of, 73
- Flint Clay, Upper Freeport, 23
- Formation, Allegheny, 20
  - Catskill, 16
  - Chemung, 16
  - Conemaugh, 26
  - Pocono, 18
  - Pottsville, 19
- Freeport, Lower, coal, 23
  - Upper, coal, 23
    - Flint Clay, 23
    - Limestone, 23

G.

- Gas Field, Bittenbender, 56-96
  - Blair, 84
  - George, 64
  - Greenville, 65
  - Leatherwood, 82
  - Miola, 39
  - Piolett, 92
  - Shamburg, 59
- George, Gas Field, 64
- Greenville, Gas field, 65

H.

- Hamilton, Jos., Well No. 1, record of, 82
- Horriger, H. Well, No. 1, record of, 54
- Heller, Henry, Well, record of, 90
- Henry, H. H., Heirs, Well, record of, 56
- Highland Township, 39
- Homewood Sandstone, 20
- Hope, Well No. 1, record of, 33
- Hundred-foot sand, 18

J.

- James, Abram, Well, record of, 42
- Johnson, George, Well, record of, 50

K.

- Kellersburg Anticline, 29
- Kifer Oil Pool, 53
- Kittanning, Lower, Clay, 25
  - Lower, Coal, 22-25
  - Middle, Coal, 23-26
  - Sandstone, 24
  - Upper, Coal, 23-26
- Knight, Wm., Well No. 1, record of, 50
- Kribb, Widow, Well No. 1, record of, 36

L.

- Leatherwood Gas Field, 82
- Lee, Well No. 1, record of, 56
- Limestone, Lower Freeport, 23
  - Township, 64
  - Upper Freeport, 23
  - Vanport, 22
- Location of quadrangle, 15
- Lower, Chas., Well No. 1, record of, 80
- Lower Freeport coal, 23
  - Limestone, 23
- Kittanning Clay, 25
  - Coal, 25

Mc.

- McElrary, Charlie, Well, record of, 54
- McElwen, F. C., Well No. 1, record of, 60
- McNutt, Gordon, Well No. 19, record of, 83

M.

Page.
- Madison Township, 103
  - Well, No. 2, record of, 59
- Mahoning coal, 26
  - sandstone, 26
  - Township, Armstrong County, 77
- Manor Oil pool, 37
- Mercer Shales, 20
- Middle Kittanning Coal, 23-26
- Mill Creek Township, 42
- Miller, J. B., Well No. record of, 6
- Miola Anticline, 30
  - Oil and Gas field, 39
- Mississippian Series, 18
- Monroe Township, 51

N.

- Neil, W. C., Well No. 3, record of, 49
- Norman School, Well No. 1, record of, 48

O.

- Olison, John, Well No. 1, record of, 35

P.

- Paint Township, 37
- Pennsylvania Series, 19
- Phillips, C. L., well, record of, 56
  - Grant, well, record of, 93
- Piney Township, 58
- Piolett Gas Field, 92
- Pocono Formation, 18
  - Sandstone, 18
- Pottsville Formation, 19

R.

- Raybrook, Mrs. Chrissie, Well, record of, 74
- Red Bark Township, 72
  - Armstrong County, 77
- Reid, B. F., Well No. 1, record of, 51
- Reidsburg Syncline, 30
- Rimersburg Anticline, 29

S.

- Sandstone, Connoqueenessing, 20
  - Homewood, 20
  - Hundred-foot, 18
  - Kittanning, 24
  - Mahoning, 26
  - Pocono, 18
- Shamburg Oil and Gas Pool, 59
- Sheridan, Wm., Well, record of, 94
- Shirley, J. B., Well No. 14, record of, 77
  - Well No. 15, record of, 78
  - Lafayette, Well, record of, 53
- Shoemaker, J. G., Well, record of, 81
- Simpson, Mrs. L. J., Well, record of, 85
- Slaughenhaupt, J. B., Well, record of, 96
- Sligo Well, record of, 62
  - Furnace well, record of, 63
- Sloan, N. H., Well, No. 1, record of, 70
  - N. P., Well, record of, 69
- Snyder, Stewart, Well No. 1, record of, 66
- Spurr, S. E. and S. R., Well No. 1, record of, 67
- Stephens, Will, Well, record of, 101
- Stewart, A. A., Well, record of, 71
  - Well, record of, 102
- Stratigraphy, 15
- Strotman Well No. 1, record of, 33
- Structure, 27
  - Beaver Township, 35
  - Contours, accuracy of, 28
  - Elk City Pool, 31
  - Manor Oil Pool, 38
  - Maps, 27

Page.

- Structural features, 29
- Snycline, Bradys Bend, 30
  - Clarion, 30
  - Fairmount, 29
  - Reidsburg, 30

T.

- Toby Township, 100
- Topographical features, 15
- Transmittal, Letter of, 11
- Truett, W. W., Well, record of, 79

U.

- Upper Freeport Coal, 23
  - Flint Clay, 23
  - Limestone, 23
  - Kittanning Coal, 23-26

V.

- Vanport Limestone, 22

W.

- Walker, J. T., Well No. 19, record of, 78
- Wasson, John, Well No. 2, record of, 60
- Wells, List of, 105
- Well, record of Abrams, J. H., No. 2, 104
  - Barber No. 1, 49
  - Bashline No. 1, 55
  - Beal, Samuel, No. 1, 36
  - Beatty, David, No. 18, 81
  - Bittenbender, Jacob-Alice Longwell, 97
  - Blair, Calvin, No. 1, 85
    - No. 2, 84
  - Blair, C. E., No. 2, 88
    - C. E. & W. S., 87
  - Blyson Run, 44
  - Bodenhorn, M. T., 73
  - Brumaker, A. A., 95
    - Jacob, 75
  - Buffington, Orr, 67
  - Connor, D., No. 1, 52
  - Corbett, Eva, 91
  - Craig, W. H., No. 1, 104
  - Delp, George, 89
  - Ditty, Scott B., No. 1, 75
  - Downs, Jos., 100
  - Ferguson, B. B., No. 1, 73
  - Hamilton, Jos., No. 1, 82
  - Harriger, H., No. 1, 54
  - Heller, Henry, 90
  - Henry, H. H. Heirs, 56
  - Hope, No. 1, 33
  - James, Abram, 42
  - Johnson, George, 50
  - Knight, Wm. No. 1, 50
  - Kribb, Widow, No. 1, 36
  - Lee, No. 1, 56
  - Lower, Charley, No. 1, 80
  - McElrary, Charlie, 54
  - McEwin, L. C. No. 1, 60
  - McNutt, Gordon, No. 19, 83
  - Madison, No. 2, 59
  - Miller, J. B., No. 1, 61
  - Neil, W. C., No. 3, 49
  - Normal School, No. 1, 48
  - Olison, John, No. 1, 35
  - Phillips, C. L., 56
    - Grant, 93
  - Raybuck, Mrs. Chrissie, 74
  - Reid, B. F., No. 1, 57
  - Sheridan, Wm., 94
  - Shirley, J. B., No. 14, 77
    - No. 15, 78
    - Lafayette, 53

Page.
- Shoemaker, J. G., 87
- Simpson, Mrs. L. J., 85
- Slaughenhaupt, J. B., 96
- Sligo, 62
  - Furnace, 63
- Sloan, N. H., No. 1, 70
  - N. P., 69
- Snyder, Stewart, No. 1, 66
- Spurr, S. E. & S. R., No. 1, 67
- Stephens, Will, 101
- Stewart, 102
  - A. A., 71
- Strotman, No. 1, 33
- Truett, W. W., No. 1, 79
- Walker, J. T., No. 19, 78
- Wasson, John, No. 2, 60
- Whisner, Albert, No. 1, 41
- Wood, George, No. 1, 44
- Worneldorf, Henry, 91

Whisner, Albert, Well No. 1, record of, 41
Wood, George, Well No. 1, record of, 44
Worneldorf, Henry, Well, record of, 91